



(51) International Patent Classification:

H05K 7/20 (2006.01)

B32B 9/04 (2006.01)

B32B 9/00 (2006.01)

B32B 27/20 (2006.01)

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(21) International Application Number:

PCT/KR2022/009844

Published:

— with international search report (Art. 21(3))

(22) International Filing Date:

07 July 2022 (07.07.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

10-2021-0090382 09 July 2021 (09.07.2021) KR

(71) Applicant: NEOGRAF SOLUTIONS, LLC [US/US];

11709 Madison Avenue, Lakewood, Ohio 44107 (US).

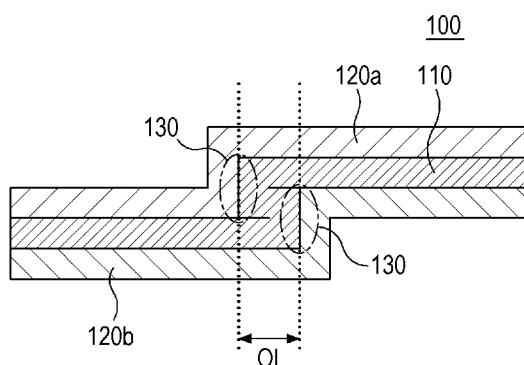
(72) Inventor: KIM, Ki Ho; 1802-702, 270 Neureul 1-ro, Namyangju-si, Gyeonggi-do 12146 (KR).

(74) Agent: YANG, Young June et al.; Kim & Chang, Seyang B/D, 39 Sajikno-8-gil, Jongno-gu, Seoul 03170 (KR).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

(54) Title: FLEXIBLE GRAPHITE STRUCTURE



(57) Abstract: Disclosed is a flexible graphite structure that can be used as a heat dissipation sheet of a flexible electronic device through a graphite sheet unit including a stretchable area formed as a cut area or an overlapping area. A disclosed flexible graphite structure includes: a graphite sheet unit comprising a single graphite sheet layer or multiple graphite sheet layers having at least one stretchable area; and a stretchable sheet layer configured to be attached to at least one of both outermost sides of the graphite sheet unit and to cover the at least one stretchable area, wherein the at least one stretchable area is formed by providing at least one pair of cutout areas in the single graphite sheet layer or by providing an overlapping area where the single graphite sheet layer or the multiple graphite sheet layers overlap.



Description

Title of Invention: FLEXIBLE GRAPHITE STRUCTURE

Technical Field

- [1] The present disclosure is a flexible graphite structure formed by using a graphite sheet unit including a stretchable area by a cutout area or an overlapping area as a heat dissipation layer, and bonding a stretchable sheet layer to at least one outermost surface of the graphite sheet unit for protecting the graphite sheet unit.

Background Art

- [2] As portable/mobile devices, such as cameras, mobile phones, mobile computers, and tablets, have evolved over several decades, the needs and capabilities of these devices have also evolved. In each generation of devices, devices have been enabling users to create, modify, and deliver content from their devices, as well as being able to provide more content to their users in a more user-friendly format at ever higher bandwidth than ever before. As the convenience of these devices has been improved, the power requirements for the devices have increased, and the technology associated with the batteries of these devices has been improved. Today's generation of devices contain more energy, generate more power, and as a result generate more heat. In addition to batteries, the hardware items of devices (e.g., radio units, displays, and processing units) have also become more robust, which have likewise created additional thermal issues for these devices.
- [3] In order to solve such a thermal problem, a technique for attaching a graphite sheet layer having high thermal conductivity to a heat generating portion of an electronic device has been devised. When a graphite sheet layer is attached to the rear surface of a portion where a lot of heat is generated in an electronic device, the thermal conductivity in the plane direction of the graphite sheet layer is relatively large compared to the thermal conductivity in the thickness direction of the graphite sheet layer. Thus, heat diffuses and moves efficiently, and through this, heat generated in the electronic device is radiated to the outside through the graphite sheet layer.
- [4] In recent years, as the technology of portable/mobile devices has been further developed, devices equipped with various displays, such as a flexible display which is bendable, and a foldable display which folds and unfolds, have been developed. In order to dissipate heat from such a device, flexibility of a heat dissipation sheet itself is required. However, the use of a graphite sheet, which is excellent in horizontal heat transfer characteristic, in flexible electronic devices has been limited due to its low flexibility.

Disclosure of Invention

Technical Problem

- [5] The present disclosure is to solve a problem in that it is difficult to use a graphite sheet as a heat dissipation sheet in a flexible electronic device due to the low flexibility of the graphite sheet, and provides a flexible graphite structure that can be used as a heat dissipation sheet of a flexible electronic device via a graphite sheet unit including a stretchable area including a cutout area or an overlapping area.

Solution to Problem

- [6] A flexible graphite structure according to an embodiment of the present disclosure includes: a graphite sheet unit including a single graphite sheet layer or multiple graphite sheet layers having at least one stretchable area; and a stretchable sheet layer configured to be attached to at least one of both outermost sides of the graphite sheet unit and to cover the at least one stretchable area, wherein the at least one stretchable area is formed by providing at least one pair of cutout areas in the single graphite sheet layer or by providing an overlapping area where the single graphite sheet layer or the multiple graphite sheet layers overlap.
- [7] The overlapping area may be formed by providing at least two foldable portions in the single graphite sheet layer such that the overlapping area is provided between the foldable portions or may be formed by overlapping portions of the multiple graphite sheet layers.
- [8] The at least one pair of cutout areas may be provided in a point symmetric manner in the single graphite sheet layer, and the single graphite sheet layer may be connected in one sheet in the other areas than the cutout area.
- [9] The at least one pair of cutout areas may have a smaller length than the graphite sheet layer in a direction perpendicular to a stretchable direction of the flexible graphite structure.
- [10] The length of the at least one pair of cutout areas may be 90% or less or 75% or less of the length of the graphite sheet layer in the direction perpendicular to the stretchable direction of the flexible graphite structure.
- [11] The at least one stretchable area may include a void space extending in the direction perpendicular to the stretchable direction of the flexible graphite structure.
- [12] The void space may be defined between a graphite sheet layer provided in another area than the overlapping area and a graphite sheet layer provided in the overlapping area, or defined by the at least one pair of cutout areas.
- [13] If a force is applied to the flexible graphite structure, the graphite sheet unit may be extended, the stretchable sheet layer may be elongated in a direction where the graphite sheet unit is extended, and the width of the overlapping area may be reduced.
- [14] If the force is released, the stretchable sheet layer may be contracted and the width of

the overlapping area may be increased.

- [15] If a force is applied to the flexible graphite structure, the graphite sheet unit may be extended, the stretchable sheet layer may be elongated in a direction where the graphite sheet unit is extended, and the size of the void space of the at least one pair of cutout areas may be increased.
- [16] If the force is released, the stretchable sheet layer may be contracted, and the size of the void space of the at least one pair of cutout areas may be reduced.
- [17] The graphite sheet layer may include a graphitized polymer or compressed particles of exfoliated graphite, or a combination thereof.
- [18] The stretchable sheet layer may include at least one selected among the group consisting of polydimethylsiloxane (PDMS), an epoxy resin, a styrene-based material, an olefin-based material, polyolefin, polyurethane, thermoplastic polyurethane, a thermoplastic elastomer, polyamides, synthetic rubbers, polybutadiene, polyisobutylene, polychloroprene and silicones.
- [19] The stretchable sheet layer may have an elongation of 175% or greater, 200% or greater, or 250% or greater.
- [20] The stretchable sheet layer may include a thermally conductive material.
- [21] The graphite sheet layer may have a thickness of 15 μm -19 μm , or 16 μm -18 μm .
- [22] The graphite sheet unit may include an adhesive layer provided in the graphite sheet layer, wherein the graphite sheet unit may have a uniform thickness.
- [23] The adhesive layer may include at least one selected among the group consisting of a pressure sensitive adhesive (PSA), a thermosetting adhesive, a photo curable adhesive, an optical clear adhesive (OCA), an optical clear resin (OCR), a double-sided adhesive film, and a single-sided adhesive film.
- [24] When the adhesive layer is formed between the multiple graphite sheet layers spaced from each other, the adhesive layer may be a double-sided adhesive film.
- [25] When the adhesive layer is formed between the graphite sheet layer and the stretchable sheet layer, the adhesive layer may be a single-sided adhesive film.
- [26] The single-sided adhesive film may be bonded to a surface facing the graphite sheet layer.
- [27] The adhesive layer formed between the graphite sheet layer and the stretchable sheet layer may be segmented along the foldable portions of the graphite sheet layer.
- [28] The graphite sheet layer may have an in-plane thermal conductivity of 150W/mK-1700W/mK.
- [29] When the stretchable sheet layer is stretched, the length of the stretchable sheet layer corresponding to the segmented portion of the adhesive layer may be elongated from greater than 0 to 50% or less, or from greater than 0 to 30% or less.

Advantageous Effects of Invention

- [30] According to the disclosed flexible graphite structure, by making the graphite sheet unit include at least one stretchable area formed by providing a cutout area or an overlapping area, the graphite structure can be used as a heat dissipation sheet in a flexible electronic device to ensure an excellent heat dissipation property.

Brief Description of Drawings

- [31] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the present disclosure.
- [32] FIGS. 1A, 2A, 3A, 4A, 5A, 6A, 7A, 8A, and 9A are cross-sectional views of flexible graphite structures according to various embodiments in each of which an overlapping area is formed as a stretchable area, and FIGS. 1B, 2B, 3B, 4B, 5B, 6B, 7B, 8B, and 9B are respective cross-sectional views of the flexible graphite structures of FIGS. 1A, 2A, 3A, 4A, 5A, 6A, 7A, 8A, and 9A when the flexible graphite structures are extended in a stretchable direction.
- [33] FIGS. 10A and 11A are plan views of graphite sheet layers according to various embodiments in which cutout areas are formed as a stretchable area, and FIGS. 10B and 11B are respective cross-sectional views of the graphite sheet layers of FIGS. 10A and 11A when the graphite sheet layers are extended in a stretchable direction.
- [34] FIG. 12A is an actual photograph of a flexible graphite structure according to an embodiment in which an overlapping area is formed as a stretchable area, and FIG. 12B is an actual photograph of the flexible graphite structure of FIG. 12A when the flexible graphite is extended in a stretchable direction.
- [35] FIG. 13A is an actual photograph of a flexible graphite structure according to an embodiment in which cutout areas are formed as a stretchable area, and FIG. 13B is an actual photograph of the flexible graphite structure of FIG. 13A when the flexible graphite is extended in a stretchable direction.

Mode for the Invention

- [36] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings such that a person of ordinary skill in the art to which the present disclosure belongs can easily carry out the present disclosure. However, the present disclosure may be implemented in many different forms, and is not limited to the embodiments described herein. In order to clearly describe the present disclosure with the drawings, parts irrelevant to the description are omitted, and similar reference numerals are assigned to similar parts throughout the specification.
- [37] Throughout the specification, when a part is "connected" with another part, this includes not only the case of being "directly connected" but also the case of being "elec-

trically connected" with another element interposed therebetween. When a certain part includes a certain constituent element, it means that the certain part may include other elements rather than excluding other elements unless specifically stated otherwise.

- [38] FIG. 1A is a cross-sectional view of a flexible graphite structure 100 according to an embodiment of the present disclosure in which an overlapping area is formed as a stretchable area.
- [39] Referring to FIG. 1A, the flexible graphite structure 100 includes a graphite sheet layer 110 and stretchable sheet layers 120a and 120b attached to both sides of the graphite sheet layer 110.
- [40] The graphite sheet layer 110 includes a graphitized polymer or compressed particles of exfoliated graphite, and is excellent in longitudinal and transverse thermal conductivity on a two-dimensional plane so that it can be used as a heat dissipation sheet for dissipating the heat of a heat generating element to the outside.
- [41] The graphite sheet layer 110 has a thickness of about 14 μm - 940 μm . The graphite sheet layer 110 may have a thickness of about 14 μm - 20 μm , including about 15 μm - 19 μm , and about 16 μm - 18 μm . When the graphite sheet layer 110 is used in a flexible electronic device having a large internal allowable thickness, the graphite sheet layer 110 may have a thickness of about 20 μm - 30 μm , including about 27 μm - 37 μm , about 35 μm - 45 μm , and about 40 μm - 50 μm . In addition, the graphite sheet layer 110 may have a thickness of 40 μm - 940 μm . As the thickness of the graphite sheet layer 110 increases, the heat dissipation performance of the graphite sheet layer may increase. However, the thickness of the graphite sheet layer 110 may be determined depending on the size of the space allowed in the flexible electronic device in which the graphite sheet layer 110 is mounted.
- [42] The in-plane thermal conductivity of the graphite sheet layer 110 may be about 150 W/mK - 1700 W/mK.
- [43] The graphite sheet layer 110 includes at least two foldable portions 130 formed by folding the graphite sheet layer 110, and between the two foldable portions 130, an overlapping area OL is formed by the two foldable portions 130. The overlapping area OL refers to an area where portions of the graphite sheet layer 110 overlap each other when viewed in the vertical direction of FIG. 1A, that is, in the depth direction of the flexible graphite structure 100.
- [44] The stretchable sheet layers 120a and 120b are attached to both sides of the graphite sheet layer 110 in a state in which the overlapping area OL by the two foldable portions 130 are formed on the graphite sheet layer 110. The stretchable sheet layer includes any materials with the elongation described below, and may include, for example, at least one selected among the group consisting of polydimethylsiloxane (PDMS), an epoxy resin, a styrene-based material, an olefin-based material, polyolefin,

polyurethane, thermoplastic polyurethane, a thermoplastic elastomer, polyamides, synthetic rubbers, polybutadiene, polyisobutylene, polychloroprene and silicones, but is not limited thereto.

[45] When a force is applied in the longitudinal direction or the width direction, the stretchable sheet layers 120a and 120b are elongated along a direction where the force is applied, and when the force is released, the stretchable sheet layers 120a and 120b return to the original lengths thereof. The stretchable sheet layers 120a and 120b may have an elongation of 175% or more, or 200% or more, or 250% or more, wherein the elongation refers to a ratio of a length of a stretchable sheet layer when a force is applied thereto relative to the original length of the stretchable sheet without the force applied thereto. For example, the original length is 100%, and thus an elongation of 175% would be 75% greater than the original length (100%). In another example, an elongation of 200% would be two times (twice) the length of the original length (100%).

[46] The stretchable sheet layers 120a and 120b may include a thermally conductive material. The thermally conductive material may be a metallic bead, a polymer bead having a high thermal conductivity, or the like, but is not limited thereto. Since the stretchable sheet layers 120a and 120b include a thermally conductive material, when the flexible graphite structure 100 is used as a heat dissipation sheet of an electronic device, heat generated in the electronic device can be more efficiently radiated to the outside.

[47] The foldable portions 130 of the graphite sheet layer 110 and the stretchable sheet layers 120a and 120b are not bonded to each other, and void spaces may be defined. That is, the overlapping area OL may include void spaces, and the void spaces may extend in a direction perpendicular to the stretchable of the flexible graphite structure 100. Due to the existence of the void spaces, when a force is applied to the flexible graphite structure 100, the flexible graphite structure 100 may be extended in the direction of the force.

[48] FIG. 1B is a cross-sectional view of the flexible graphite structure 100 when the flexible graphite structure 100 is extended in the stretchable direction.

[49] Referring to FIG. 1B, the flexible graphite structure 100 may be used as a heat dissipation sheet in an electronic device equipped with a flexible display which is bendable or a foldable display which folds and unfolds, and when a user manipulates the electronic device such that the display of the electronic device is bent or folded, a force of pulling the flexible graphite structure 100 to the opposite sides may be applied to the flexible graphite structure 100.

[50] When the force of pulling the flexible graphite structure 100 is applied to the flexible graphite structure 100, the stretchable sheet layers 120a and 120b are elongated along

the direction of the force, and since the graphite sheet layer 110 is integrally bonded to the stretchable sheet layers 120a and 120b, the graphite sheet layer 110 is also extended to the opposite sides along the direction of the force. Since the graphite sheet layer 110 does not have stretchability, if the graphite sheet layer is a flat graphite sheet, it will not be extended even if a force is applied thereto. However, since the graphite sheet layer 110 of the flexible graphite structure 100 according to the present embodiment has the overlapping area OL formed by two foldable portions 130, the graphite sheet layer 110 can also be extended to the opposite sides along the direction of the force as the foldable portions 130 of the graphite sheet layer 110 are unfolded in response to the application of the force.

[51] As the graphite sheet layer 110 is extended to the opposite sides, the width of the overlapping area OL gradually decreases, and when the graphite sheet layer 110 is maximally extended, the overlapping area OL may disappear.

[52] Since the graphite sheet layer 110 according to the present embodiment has a double-folded shape including two foldable portions 130, the length of the maximally extended flexible graphite structure 100 illustrated in FIG. 1B may be longer than the length of the flexible graphite structure 100 before extension as illustrated in FIG. 1A by twice the length of the overlapping area OL.

[53] When the user returns the electronic device to its original state after the operation of bending or folding the display of the electronic device is performed, the force of pulling the flexible graphite structure 100 is released from the flexible graphite structure 100. When the force of pulling the flexible graphite structure 100 to the opposite sides is released, the stretchable sheet layers 120a and 120b are contracted back to their original lengths, and accordingly, the width of the overlapping area OL increases while the two foldable portions 130 are also formed in the graphite sheet layer 110. As the contraction of the stretchable sheet layers 120a and 120b is terminated, the flexible graphite structure 100 returns to its original shape, that is, to the shape illustrated in FIG. 1A.

[54] As the force is applied to and released from the flexible graphite structure 100, the above-described operation is repeatedly performed. Through this operation, heat dissipation of the flexible electronic device can be smoothly performed even when a graphite structure with a high thermal conductivity but low flexibility is used as a heat dissipation sheet.

[55] FIG. 2A is a cross-sectional view of a flexible graphite structure 200 according to an embodiment of the present disclosure in which an overlapping area is formed as a stretchable area.

[56] Referring to FIG. 2A, the flexible graphite structure 200 includes a graphite sheet unit 215 including two graphite sheet layers 210a and 210b and stretchable sheet layers

220a and 220b attached to both sides of the graphite sheet unit 215.

- [57] The graphite sheet layers 210a and 210b and the stretchable sheet layers 220a and 220b may be formed of the same materials as the aforementioned graphite sheet layer 110 and the stretchable sheet layers 120a and 120b, respectively, and overlapping descriptions will be omitted.
- [58] The graphite sheet unit 215 includes an overlapping area OL formed by overlapping the two graphite sheet layers 210a and 210b. The overlapping area OL refers to an area in which the two graphite sheet layers 210a and 210b overlap each other when viewed in the vertical direction of FIG. 2A, that is, in the depth direction of the flexible graphite structure 200.
- [59] The stretchable sheet layers 220a and 220b are attached to both sides of the graphite sheet unit 215 in a state in which the overlapping area OL formed by overlapping the two graphite sheet layers 210a and 210b on the graphite sheet unit 215 is formed.
- [60] In the area where steps are formed in the graphite sheet unit 215, that is, in the overlapping area OL, the end portions of the graphite sheet layers 210a and 210b and the stretchable sheet layers 220a and 220b are not bonded to each other, and void spaces are defined. That is, the overlapping area OL may include void spaces on the opposite sides thereof, and the void spaces may extend in a direction perpendicular to the stretchable direction of the flexible graphite structure 200. Due to the existence of the void spaces, when a force is applied to the flexible graphite structure 200, the flexible graphite structure 200 may be extended in the direction of the force.
- [61] FIG. 2B is a cross-sectional view of the flexible graphite structure 200 when the flexible graphite structure 200 is extended in the stretchable direction.
- [62] Referring to FIG. 2B, when a user manipulates the electronic device such that the display of the electronic device is bent or folded, a force of fulling the flexible graphite structure 200 to the opposite sides may be applied to the flexible graphite structure 200.
- [63] When the force of fulling the flexible graphite structure 200 to the opposite sides is applied to the flexible graphite structure 200, the stretchable sheet layers 220a and 220b are extended along the direction of the force, and since the graphite sheet unit 215 is integrally bonded to the stretchable sheet layers 220a and 220b, the graphite sheet layer 210a of the graphite sheet unit 215 moves in one direction, and the graphite sheet layer 210b moves in the opposite direction to the one direction. In particular, since the two graphite sheet layers 210a and 210b are not bonded to each other, but are stacked on each other, the graphite sheet layers can slide and move in the opposite directions by the application of the force. As the two graphite sheet layers 210a and 210b move in the opposite directions, the graphite sheet unit 215 is also extended to the opposite sides.

- [64] As the graphite sheet unit 215 is extended to the opposite sides, the width of the overlapping area OL gradually decreases, and until the overlapping area OL by the two graphite sheet layers 210a and 210b completely disappears, the flexible graphite structure 200 can be extended.
- [65] When the user returns the electronic device to its original state after the operation of bending or folding the display of the electronic device is performed, the force of pulling the flexible graphite structure 200 to the opposite sides is released from the flexible graphite structure 200. When the force of pulling the flexible graphite structure 200 to the opposite sides is released, the stretchable sheet layers 220a and 220b are contracted back to their original lengths again, and accordingly, the width of the overlapping area OL of the graphite sheet unit 215 increases. As the contraction of the stretchable sheet layers 220a and 220b is terminated, the flexible graphite structure 200 returns to its original shape, that is, to the shape illustrated in FIG. 2A.
- [66] In response to forces that are applied to and released from the flexible graphite structure 200, the above-described operation is repeatedly performed. Through this operation, heat dissipation of the flexible electronic device can be smoothly performed even when a graphite structure with a high thermal conductivity but low flexibility is used as a heat dissipation sheet.
- [67] FIG. 3A is a cross-sectional view of a flexible graphite structure 300 according to an embodiment of the present disclosure in which an overlapping area is formed as a stretchable area.
- [68] Referring to FIG. 3A, the flexible graphite structure 300 includes: a graphite sheet unit 350 including a graphite sheet layer 310 and adhesive layers 320a and 320b formed on the graphite sheet layer 310; and stretchable sheet layers 330a and 330b attached to the outermost both sides of the graphite sheet unit 350.
- [69] The graphite sheet layer 310 and the stretchable sheet layers 330a and 330b may be formed of the same materials as the aforementioned graphite sheet layer and stretchable sheet layers, respectively, and overlapping descriptions will be omitted.
- [70] The graphite sheet layer 310 includes at least two foldable portions 340 formed by folding the graphite sheet layer 310, and between the two foldable portions 340, an overlapping area OL is formed by the two foldable portions 340. The overlapping area OL refers to an area where portions of the graphite sheet layer 310 overlap each other when viewed in the vertical direction of FIG. 3A, that is, in the depth direction of the flexible graphite structure 300.
- [71] The adhesive layers 320a and 320b may be formed on the portions where the overlapping area OL is not formed in the graphite sheet layer 310, and it is possible to make the thickness of the graphite sheet unit 350 substantially uniform by using the adhesive layers 320a and 320b.

- [72] The adhesive layers 320a and 320b may include at least one of a pressure sensitive adhesive (PSA), a thermosetting adhesive, a photo curable adhesive, an optical clear adhesive (OCA), an optical clear resin (OCR), a double-sided adhesive film, and a single-sided adhesive film, but is not limited thereto. The single-sided adhesive film or double-sided adhesive film may include, for example, a base layer (not illustrated) formed of at least one of polyethylene terephthalate (PET), polycarbonate (PC), aluminum foil, copper foil, and polyimide (PI), and an adhesive layer (not illustrated) in which an adhesive is applied to one or both sides of the base layer.
- [73] There is no particular limitation on the type or shape of the adhesive layers 320a and 320b, but when the adhesive layers 320a and 320b are, for example, in the form of a single-sided adhesive film, the adhesive layers 320a and 320b may be formed between the graphite sheet layer 310 and the stretchable sheet layers 330a and 330b by being disposed and bonded such that the adhesion layers of single-sided adhesive films are placed on the surfaces facing the graphite sheet layer 310.
- [74] The foldable portions 340 of the graphite sheet layer 310 and the adhesive layers 320a and 320b are not bonded to each other, and void spaces may be defined. That is, the overlapping area OL may include void spaces on the opposite sides thereof, and the void spaces may extend in a direction perpendicular to the stretchable direction of the flexible graphite structure 300. Due to the existence of the void spaces, when a force is applied to the flexible graphite structure 300, the flexible graphite structure 100 may be extended along the direction of the force.
- [75] FIG. 3B is a cross-sectional view of the flexible graphite structure 300 when the flexible graphite structure 300 is extended in the stretchable direction.
- [76] Referring to FIG. 3B, when a user manipulates the electronic device such that the display of the electronic device is bent or folded, a force of pulling the flexible graphite structure 300 to either side may be applied to the flexible graphite structure 300.
- [77] When the force of pulling the flexible graphite structure 300 to the opposite sides is applied to the flexible graphite structure 300, the stretchable sheet layers 330a and 330b are stretched along the direction of the force, and since the graphite sheet unit 350 is integrally bonded to the stretchable sheet layers 330a and 330b and the graphite sheet layer 310 of the flexible graphite structure 300 includes the overlapping area OL formed by two foldable portions 340, the foldable portions 340 of the graphite sheet layer 310 are unfolded in response to the application of the force, and the graphite sheet layer 310 can also be extended to either side along the direction of the force. In addition, since both sides of the adhesive layer 320a are fixedly bonded to the graphite sheet layer 310 and the stretchable sheet layer 330a, and the both sides of the adhesive layer 320b are fixedly bonded to the graphite sheet layer 310 and the stretchable sheet layer 330b, the adhesive layers 320a and 320b move away from each other in response

to the extension of the stretchable sheet layers 330a and 330b and the graphite sheet layer 310.

[78] As the graphite sheet unit 350 is extended to either side, the width of the overlapping area OL gradually decreases, and when the graphite sheet part 350 is maximally extended, the overlapping area OL may disappear.

[79] When the user returns the electronic device to its original state after the operation of bending or folding the display of the electronic device is performed, the force of pulling the flexible graphite structure 300 to either side is released from the flexible graphite structure 300. When the force of pulling the flexible graphite structure 300 to either side is released, the stretchable sheet layers 330a and 330b are contracted back to their original lengths again, and accordingly, the width of the overlapping area OL of the graphite sheet part 350 increases. As the contraction of the stretchable sheet layers 330a and 330b is terminated, the flexible graphite structure 300 returns to its original shape, that is, to the shape illustrated in FIG. 3A.

[80] In response to forces that are applied to and released from the flexible graphite structure 300, the above-described operation is repeatedly performed. Through this operation, heat dissipation of the flexible electronic device can be smoothly performed even when a graphite structure with a high thermal conductivity but low flexibility is used as a heat dissipation sheet. In the flexible graphite structure 300 according to the present embodiment, since it is possible to make the thickness of the graphite sheet unit 350 substantially uniform in the state before extension by using the adhesive layers 320a and 320b, it is possible to attach the graphite structure to a flexible electronic device more easily.

[81] FIG. 4A is a cross-sectional view of a flexible graphite structure 400 according to an embodiment of the present disclosure in which an overlapping area is formed as a stretchable area.

[82] Referring to FIG. 4A, the flexible graphite structure 400 includes: a graphite sheet unit 450 including three graphite sheet layers 410a, 410b, and 410c and adhesive layers 420a, 420b, and 420c formed on the graphite sheet layer 410a, 410b, and 410c; and stretchable sheet layers 430a and 430b attached to the outermost both sides of the graphite sheet unit 450.

[83] The three graphite sheet layers 410a, 410b, and 410c, the adhesive layers 420a, 420b, and 420c, and the stretchable sheet layers 430a and 430b may be formed of the same materials as the aforementioned graphite sheet layers, adhesive layers, and stretchable sheet layers, respectively, and overlapping descriptions will be omitted.

[84] The graphite sheet unit 450 includes an overlapping area OL formed by overlapping the three graphite sheet layers 410a, 410b, and 410c. The overlapping area OL refers to an area in which the three graphite sheet layers 410a, 410b, and 410c overlap each

other when viewed in the vertical direction of FIG. 4A, that is, in the depth direction of the flexible graphite structure 400.

- [85] The adhesive layers 420a, 420b, and 420c may be formed on portions where the overlapping area OL is not formed in the three graphite sheet layers 410a, 410b, and 410c, wherein the adhesive layer 420a may be formed between two graphite sheet layers 410b and 410c, and the adhesive layers 420b and 420c may be formed between the graphite sheet layer 410a and the stretchable sheet layers 430a and 430b. It is possible to make the thickness of the graphite sheet unit 450 substantially uniform by using the adhesive layers 420a, 420b, and 420c.
- [86] There is no particular limitation on the type or shape of the adhesive layer 420a formed between the two graphite sheet layers 410b and 410c that are spaced apart from each other. However, when the adhesive layer 420a is, for example, in the form of an adhesive film, the adhesive layer is preferably a double-sided adhesive film since adhesion layers are required on the both sides thereof that face the graphite sheet layers 410b and 410c in order to be bonded to the graphite sheet layers 410b and 410c.
- [87] When the adhesive layers 420b and 420c formed between the graphite sheet layer 410a and the stretchable sheet layers 430a and 430b are, for example, in the form of an adhesive film, each of the adhesive layers may not only be a double-sided adhesive film, but also a single-sided adhesive film since it is sufficient if an adhesion layer can be disposed on a surface that faces the graphite sheet layer 410a.
- [88] In the overlapping area OL, the end portions of the three graphite sheet layers 410a, 410b, and 410c and the adhesive layers 420a, 420b, and 420c are not bonded to each other, and void spaces may be defined. That is, the overlapping area OL may include void spaces on the opposite sides thereof, and the void spaces may extend in a direction perpendicular to the stretchable direction of the flexible graphite structure 400. Due to the existence of the void spaces, when a force is applied to the flexible graphite structure 400, the flexible graphite structure 100 may be extended along the direction of the force.
- [89] FIG. 4B is a cross-sectional view of the flexible graphite structure 400 when the flexible graphite structure 400 is extended in the stretchable direction.
- [90] Referring to FIG. 4B, when a user manipulates the electronic device such that the display of the electronic device is bent or folded, a force of pulling the flexible graphite structure 400 to either side may be applied to the flexible graphite structure 400.
- [91] When the force of pulling the flexible graphite structure 400 to either side is applied, the stretchable sheet layers 430a and 430b are extended along the direction of the force, and since the graphite sheet unit 450 is integrally bonded to the stretchable sheet layers 430a and 430b, the graphite sheet layer 410a of the graphite sheet unit 450 moves in one direction, and the graphite sheet layers 410b and 410c move in the

opposite direction to the one direction. In particular, since the three graphite sheet layers 410a, 410b, and 410c are not bonded to each other, but are stacked on each other, the graphite sheet layers can slide and move in the opposite directions by the application of the forces. Since the graphite sheet layer 410a and the two graphite sheet layers 410b and 410c move in the opposite directions, the graphite sheet unit 450 is also extended to either side.

[92] As the graphite sheet unit 450 is extended to either side, the width of the overlapping area OL gradually decreases, and until the overlapping area OL by the three graphite sheet layers 410a, 410b, and 410c completely disappears, the flexible graphite structure 400 can be extended.

[93] When the user returns the electronic device to its original state after the operation of bending or folding the display of the electronic device is performed, the force of pulling the flexible graphite structure 400 to either side is released from the flexible graphite structure 400. When the force of pulling the flexible graphite structure 400 to either side is released, the stretchable sheet layers 430a and 430b are contracted back to their original lengths again, and accordingly, the width of the overlapping area OL of the graphite sheet part 450 increases. As the contraction of the stretchable sheet layers 430a and 430b is terminated, the flexible graphite structure 400 returns to its original shape, that is, to the shape illustrated in FIG. 4A.

[94] In response to forces that are applied to and released from the flexible graphite structure 400, the above-described operation is repeatedly performed. Through this operation, heat dissipation of the flexible electronic device can be smoothly performed even when a graphite structure with a high thermal conductivity but low flexibility is used as a heat dissipation sheet. In the flexible graphite structure 400 according to the present embodiment, since it is possible to make the thickness of the graphite sheet unit 450 substantially uniform in the state before extension by using the adhesive layers 420a, 420b, and 420c, it is possible to attach the graphite structure to a flexible electronic device more easily.

[95] FIG. 5A is a cross-sectional view of a flexible graphite structure 500 according to an embodiment of the present disclosure in which an overlapping area is formed as a stretchable area.

[96] Referring to FIG. 5A, the flexible graphite structure 500 includes: a graphite sheet unit 550 including two graphite sheet layers 510a and 510b and adhesive layers 520a and 520b formed on the graphite sheet layer 510a and 510b; and stretchable sheet layers 530a and 530b attached to the outermost both sides of the graphite sheet unit 550.

[97] The two graphite sheet layers 510a and 510b, the adhesive layers 520a and 520b, and the stretchable sheet layers 530a and 530b may be formed of the same materials as the

aforementioned graphite sheet layers, adhesive layers, and stretchable sheet layers, respectively, and overlapping descriptions will be omitted.

- [98] The graphite sheet unit 550 includes an overlapping area OL formed by overlapping the two graphite sheet layers 510a and 510b. The overlapping area OL refers to an area in which the two graphite sheet layers 510a and 510b overlap each other when viewed in the vertical direction of FIG. 5A, that is, in the depth direction of the flexible graphite structure 500.
- [99] The adhesive layers 520a and 520b may be formed on the portions where the overlapping area OL is not formed in the graphite sheet layers 510a and 510b, and it is possible to make the thickness of the graphite sheet unit 550 substantially uniform by using the adhesive layers 520a and 520b.
- [100] There is no particular limitation on the type or shape of the adhesive layers 520a and 520b, but when the adhesive layers 520a and 520b are, for example, in the form of a single-sided adhesive film, the adhesive layers 520a and 520b may be formed between the graphite sheet layers 510a and 510b and the stretchable sheet layers 530a and 530b by being disposed and bonded such that the adhesion layers of single-sided adhesive films are placed on the surfaces facing the graphite sheet layers 510a and 510b.
- [101] In the overlapping area OL, the end portions of the two graphite sheet layers 510a and 510b and the adhesive layers 520a and 520b are not bonded to each other, and void spaces may be defined. That is, the overlapping area OL may include void spaces on the opposite sides thereof, and the void spaces may extend in a direction perpendicular to the stretchable direction of the flexible graphite structure 500. Due to the existence of the void spaces, when a force is applied to the flexible graphite structure 500, the flexible graphite structure 500 may be extended along the direction of the force.
- [102] FIG. 5B is a cross-sectional view of the flexible graphite structure 500 when the flexible graphite structure 500 is extended in the stretchable direction.
- [103] Referring to FIG. 5B, when a user manipulates the electronic device such that the display of the electronic device is bent or folded, a force of pulling the flexible graphite structure 500 to either side may be applied to the flexible graphite structure 500.
- [104] When the force of pulling the flexible graphite structure 500 to either side is applied to the flexible graphite structure 500, the stretchable sheet layers 530a and 530b are extended along the directions of the forces, and since the graphite sheet unit 550 is integrally bonded to the stretchable sheet layers 530a and 530b, the graphite sheet layer 510a of the graphite sheet unit 550 moves in one direction, and the graphite sheet layer 510b moves in the opposite direction to the one direction. In addition, since the both sides of the adhesive layer 520a are fixedly bonded to the graphite sheet layer 510b and the stretchable sheet layer 530a, and the both sides of the adhesive layer 520b are fixedly bonded to the graphite sheet layers 510a and the stretchable sheet layer 530b,

the adhesive layers 520a and 520b move away from each other in response to the extension of the stretchable sheet layers 530a and 530b and the graphite sheet layers 510a and 510b. In particular, since the two graphite sheet layers 510a and 510b are not bonded to each other, but are stacked on each other, the graphite sheet layers can slide and move in the opposite directions by the application of the forces. As the two graphite sheet layers 510a and 510b move in the opposite directions, the graphite sheet unit 550 is also extended in the opposite directions.

[105] As the graphite sheet unit 550 is extended to either side, the width of the overlapping area OL gradually decreases, and until the overlapping area OL by the two graphite sheet layers 510a and 510b completely disappears, the flexible graphite structure 500 can be extended.

[106] When the user returns the electronic device to its original state after the operation of bending or folding the display of the electronic device is performed, the force of pulling the flexible graphite structure 500 to either side is released from the flexible graphite structure 500. When the force of pulling the flexible graphite structure 500 to either side is released, the stretchable sheet layers 530a and 530b are contracted back to their original lengths again, and accordingly, the width of the overlapping area OL of the graphite sheet unit 550 increases. As the contraction of the stretchable sheet layers 530a and 530b is terminated, the flexible graphite structure 500 returns to its original shape, that is, to the shape illustrated in FIG. 5A.

[107] As the forces are applied to and released from the flexible graphite structure 500, the above-described operation is repeatedly performed. Through this operation, heat dissipation of the flexible electronic device can be smoothly performed even when a graphite structure with a high thermal conductivity but low flexibility is used as a heat dissipation sheet. In the flexible graphite structure 500 according to the present embodiment, since it is possible to make the thickness of the graphite sheet unit 550 substantially uniform in the state before extension by using the adhesive layers 520a and 520b, it is possible to attach the graphite structure to a flexible electronic device more easily.

[108] FIG. 6A is a cross-sectional view of a flexible graphite structure 600 according to an embodiment of the present disclosure in which an overlapping area is formed as a stretchable area.

[109] Referring to FIG. 6A, the flexible graphite structure 600 includes: a graphite sheet unit 650 including three graphite sheet layers 610a, 610b, and 610c and adhesive layers 620a and 620b formed on the graphite sheet layer 610a, 610b, and 610c; and stretchable sheet layers 630a and 630b attached to the outermost both sides of the graphite sheet unit 650.

[110] The graphite sheet layers 610a, 610b, and 610c, the adhesive layers 620a and 620b,

and the stretchable sheet layers 630a and 630b may be formed of the same materials as the aforementioned graphite sheet layers, adhesive layers, and stretchable sheet layers, respectively, and overlapping descriptions will be omitted.

- [111] The graphite sheet layer 610a includes at least two foldable portions 640 formed by folding the graphite sheet layer 610a, and between the two foldable portions 640, an overlapping area OL is formed by the two foldable portions 640. The overlapping area OL refers to an area where portions of the graphite sheet layer 610a overlap each other when viewed in the vertical direction of FIG. 6A, that is, in the depth direction of the flexible graphite structure 600.
- [112] The adhesive layers 620a and 620b may be formed on portions where the overlapping area OL is not formed in the graphite sheet layers 610a, 610b, and 610c, wherein the adhesive layer 620a may be formed between the graphite sheet layer 610a and the graphite sheet layer 610b, and the adhesive layer 620b may be formed between the graphite sheet layer 610a and the graphite sheet layer 610c. It is possible to make the thickness of the graphite sheet unit 650 substantially uniform by using the adhesive layers 620a and 620b and the graphite sheet layers 610b and 610c.
- [113] There is no particular limitation on the type or shape of the adhesive layers 620a and 620b formed between the graphite sheet layers 610a, 610b, and 610c that are spaced apart from each other. However, when the adhesive layers 620a and 620b are, for example, in the form of an adhesive film, the adhesive layers are preferably double-sided adhesive films since adhesion layers are required on the both sides thereof that face the graphite sheet layers 610a, 610b, and 610c in order to be bonded to the graphite sheet layers 610a, 610b, and 610c.
- [114] The foldable portions 640 of the graphite sheet layer 610a, the adhesive layers 620a and 620b, and the graphite sheet layers 610b and 610c are not bonded to each other, and void spaces may be defined. That is, the overlapping area OL may include void spaces on the opposite sides thereof, and the void spaces may extend in a direction perpendicular to the stretchable direction of the flexible graphite structure 600. Due to the existence of the void spaces, when a force is applied to the flexible graphite structure 600, the flexible graphite structure 600 may be extended along the direction of the force.
- [115] FIG. 6B is a cross-sectional view of the flexible graphite structure 600 when the flexible graphite structure 600 is extended in the stretchable direction.
- [116] Referring to FIG. 6B, when a user manipulates the electronic device such that the display of the electronic device is bent or folded, a force of pulling the flexible graphite structure 600 to either side may be applied to the flexible graphite structure 600.
- [117] When the force of pulling the flexible graphite structure 600 to either side is applied to the flexible graphite structure 600, the stretchable sheet layers 630a and 630b are

stretched along the direction of the force, and since the graphite sheet unit 650 is integrally bonded to the stretchable sheet layers 630a and 630b and the graphite sheet layer 610a of the flexible graphite structure 600 includes the overlapping area OL formed by two foldable portions 640, as the foldable portions 640 of the graphite sheet layer 610a are unfolded in response to the application of the force, and the graphite sheet layer 610a can also be extended to either side along the direction of the force. In addition, since the both sides of the adhesive layers 620a and 620b are fixedly attached between the graphite sheet layers 610a, 610b, and 610c, and the both sides of the graphite sheet layers 610b and 610c are fixedly attached between the stretchable sheet layers 630a and 630b and the adhesive layers 620a and 620b, the adhesive layers 620a and 620b and the graphite sheet layers 610b and 610c also move away from each other in response to the extension of the stretchable sheet layers 630a and 630b and the graphite sheet layer 610a.

[118] As the graphite sheet unit 650 is extended to either side, the width of the overlapping area OL gradually decreases, and when the graphite sheet part 650 is maximally extended, the overlapping area OL may disappear.

[119] When the user returns the electronic device to its original state after the operation of bending or folding the display of the electronic device is performed, the force of pulling the flexible graphite structure 600 to either side is released from the flexible graphite structure 600. When the force of pulling the flexible graphite structure 600 to either side is released, the stretchable sheet layers 630a and 630b are contracted back to their original lengths again, and accordingly, the width of the overlapping area OL of the graphite sheet unit 650 increases. As the contraction of the stretchable sheet layers 630a and 630b is terminated, the flexible graphite structure 600 returns to its original shape, that is, to the shape illustrated in FIG. 6A.

[120] As the forces are applied to and released from the flexible graphite structure 600, the above-described operation is repeatedly performed. Through this operation, heat dissipation of the flexible electronic device can be smoothly performed even when a graphite structure with a high thermal conductivity but low flexibility is used as a heat dissipation sheet. In the flexible graphite structure 600 according to the present embodiment, since it is possible to make the thickness of the graphite sheet unit 650 substantially uniform in the state before extension by using the adhesive layers 620a and 620b and the graphite sheet layers 610b and 610c, it is possible to attach the graphite structure to a flexible electronic device more easily.

[121] FIG. 7A is a cross-sectional view of a flexible graphite structure 700 according to an embodiment of the present disclosure in which an overlapping area is formed as a stretchable area.

[122] Referring to FIG. 7A, the flexible graphite structure 700 includes: a graphite sheet

unit 750 including four graphite sheet layers 710a, 710b, 710c, and 710d and adhesive layers 720a and 720b formed on the graphite sheet layer 710a, 710b, 710c, and 710d; and stretchable sheet layers 730a and 730b attached to the outermost both surfaces of the graphite sheet unit 750.

- [123] The graphite sheet layers 710a, 710b, 710c, and 710d, the adhesive layers 720a and 720b, and the stretchable sheet layers 730a and 730b may be formed of the same materials as the aforementioned graphite sheet layers, adhesive layers, and stretchable sheet layers, respectively, and overlapping descriptions will be omitted.
- [124] The graphite sheet unit 750 includes an overlapping area OL formed by overlapping the two graphite sheet layers 710a and 710b. The overlapping area OL refers to an area in which the two graphite sheet layers 710a and 710b overlap each other when viewed in the vertical direction of FIG. 7A, that is, in the depth direction of the flexible graphite structure 700.
- [125] The adhesive layers 720a and 720b may be formed on portions where the overlapping area OL is not formed in the graphite sheet layers 710a, 710b, 710c, and 710d, wherein the adhesive layer 720a may be formed between the graphite sheet layer 710b and the graphite sheet layer 710c, and the adhesive layer 720b may be formed between the graphite sheet layer 710a and the graphite sheet layer 710d. It is possible to make the thickness of the graphite sheet unit 750 uniform by using the adhesive layers 720a and 720b and the graphite sheet layers 710c and 710d.
- [126] There is no particular limitation on the type or shape of the adhesive layers 720a and 720b formed between the graphite sheet layers 710a, 710b, 710c, and 710d that are spaced apart from each other. However, when the adhesive layers 720a and 720b are, for example, in the form of an adhesive film, the adhesive layers are preferably double-sided adhesive films since adhesion layers are required on the both sides thereof that face the graphite sheet layers 710a, 710b, 710c, and 710d in order to be bonded to the graphite sheet layers 710a, 710b, 710c, and 710d.
- [127] In the overlapping area OL, the end portions of the two graphite sheet layers 710a and 710b are not bonded to the adhesive layers 720a and 720b and the graphite sheet layers 710c and 710d, and void spaces may be defined. That is, the overlapping area OL may include void spaces on the opposite sides thereof, and the void spaces may extend in a direction perpendicular to the stretchable direction of the flexible graphite structure 700. Due to the existence of the void spaces, when a force is applied to the flexible graphite structure 700, the flexible graphite structure 100 may be extended along the direction of the force.
- [128] FIG. 7B is a cross-sectional view of the flexible graphite structure 700 when the flexible graphite structure 700 is extended in the stretchable direction.
- [129] Referring to FIG. 7B, when a user manipulates the electronic device such that the

display of the electronic device is bent or folded, a force of pulling the flexible graphite structure 700 to either side may be applied to the flexible graphite structure 700.

[130] When a force of pulling the flexible graphite structure 700 to either side is applied to the flexible graphite structure 700, the stretchable sheet layers 730a and 730b are extended along the directions of the forces, and since the graphite sheet unit 750 is integrally bonded to the stretchable sheet layers 730a and 730b, the graphite sheet layer 710a of the graphite sheet unit 750 moves in one direction, and the graphite sheet layer 710b moves in the opposite direction to the one direction. In addition, since the both sides of the adhesive layers 720a and 720b are fixedly attached between the graphite sheet layers 710a, 710b, 710c, and 710d, and the both sides of the graphite sheet layers 710c and 710d are fixedly attached between the stretchable sheet layers 730a and 730b and the adhesive layers 720a and 720b, the adhesive layers 720a and 720b and the graphite sheet layers 710c and 710d also move away from each other in response to the extension of the stretchable sheet layers 730a and 730b and the graphite sheet layer 710a and 710b. In particular, since the two graphite sheet layers 710a and 710b are not bonded to each other, but are stacked on each other, the graphite sheet layers can slide and move in the opposite directions by the application of the forces. As the two graphite sheet layers 710a and 710b move in the opposite directions, the graphite sheet unit 750 is also extended to either side.

[131] As the graphite sheet unit 750 is extended to either side, the width of the overlapping area OL gradually decreases, and until the overlapping area OL by the two graphite sheet layers 710a and 710b completely disappears, the flexible graphite structure 700 can be extended.

[132] When the user returns the electronic device to its original state after the operation of bending or folding the display of the electronic device is performed, the force of pulling the flexible graphite structure 700 to either side is released from the flexible graphite structure 700. When the force of pulling the flexible graphite structure 700 to either side is released, the stretchable sheet layers 730a and 730b are contracted back to their original lengths again, and accordingly, the width of the overlapping area OL of the graphite sheet unit 750 increases. As the contraction of the stretchable sheet layers 730a and 730b is terminated, the flexible graphite structure 700 returns to its original shape, that is, to the shape illustrated in FIG. 7A.

[133] As the forces are applied to and released from the flexible graphite structure 700, the above-described operation is repeatedly performed. Through this operation, heat dissipation of the flexible electronic device can be smoothly performed even when a graphite structure with a high thermal conductivity but low flexibility is used as a heat dissipation sheet. In the flexible graphite structure 700 according to the present embodiment, since it is possible to make the thickness of the graphite sheet unit 750 sub-

stantially uniform in the state before extension by using the adhesive layers 720a and 720b, and the graphite sheet layers 710c and 710d, it is possible to attach the graphite structure to a flexible electronic device more easily.

[134] FIG. 8A is a cross-sectional view of a flexible graphite structure 800 according to an embodiment of the present disclosure in which an overlapping area is formed as a stretchable area.

[135] Referring to FIG. 8A, the flexible graphite structure 800 includes: a graphite sheet unit 870 including three graphite sheet layers 810a, 810b, and 810c and adhesive layers 820a, 820b, 830a, 830b, 840a, and 840b formed on the graphite sheet layer 810a, 810b, and 810c; and stretchable sheet layers 850a and 850b attached to the outermost both sides of the graphite sheet unit 870.

[136] The graphite sheet layers 810a, 810b, and 810c, the adhesive layers 820a, 820b, 830a, 830b, 840a, and 840b, and the stretchable sheet layers 850a and 850b may be formed of the same materials as the aforementioned graphite sheet layers, adhesive layers, and stretchable sheet layers, respectively, and overlapping descriptions will be omitted.

[137] The graphite sheet layer 810a includes at least two foldable portions 860 formed by folding the graphite sheet layer 810a, and, between the two foldable portions 860, an overlapping area OL is formed by the two foldable portions 860. The overlapping area OL refers to an area where portions of the graphite sheet layer 810a overlap each other when viewed in the vertical direction of FIG. 8A, that is, in the depth direction of the flexible graphite structure 800.

[138] The adhesive layers 820a and 820b may be formed on portions where the overlapping area OL is not formed in the graphite sheet layers 810a, 810b, and 810c, wherein the adhesive layer 820a may be formed between the graphite sheet layer 810a and the graphite sheet layer 810b, and the adhesive layer 820b may be formed between the graphite sheet layer 810a and the graphite sheet layer 810c. The adhesive layers 830a and 830b may be formed between the graphite sheet layers 810a and 810b and the stretchable sheet layer 850a, and the adhesive layers 840a and 840b may be formed between the graphite sheet layers 810a and 810c and the stretchable sheet layer 850b. In addition, the adhesive layers 830a, 830b, 840a, and 840b formed between the graphite sheet layers 810a, 810b, and 810c and the stretchable sheet layers 850a and 850b may be segmented along the foldable portions 860 of the graphite sheet layer 810a. It is possible to make the thickness of the graphite sheet unit 850 substantially uniform by using the adhesive layers 820a, 820b, 830a, 830b, 840a, and 840b and the graphite sheet layers 810b and 810c.

[139] There is no particular limitation on the type or shape of the adhesive layers 820a and 820b formed between the graphite sheet layers 810a, 810b, and 810c that are spaced

apart from each other. However, when the adhesive layers 820a and 820b are, for example, in the form of an adhesive film, the adhesive layers are preferably double-sided adhesive films since adhesion layers are required on the both sides thereof that face the graphite sheet layers 810a, 810b, and 810c in order to be bonded to the graphite sheet layers 810a, 810b, and 810c.

- [140] When the adhesive layers 830a, 830b, 840a, and 840b formed between the graphite sheet layers 810a, 810b, and 810c and the stretchable sheet layers 850a and 850b are, for example, in the form of an adhesive film, each of the adhesive layers may not only be a double-sided adhesive film, but also a single-sided adhesive film since it is sufficient if an adhesion layer can be disposed on a surface that faces the graphite sheet layer 810a, 810b, or 810c.
- [141] The foldable portions 860 of the graphite sheet layer 810a, the adhesive layers 820a and 820b, and the graphite sheet layers 810b and 810c are not bonded to each other, and the adhesive layers 830a, 830b, 840a, and 840b are segmented along the foldable portions 860, void spaces may be defined therebetween. Accordingly, the overlapping area OL may include void spaces on the opposite sides thereof, and the void spaces may extend in a direction perpendicular to the stretchable direction of the flexible graphite structure 800. Due to the existence of the void spaces, when a force is applied to the flexible graphite structure 800, the flexible graphite structure 800 may be extended along the direction of the force.
- [142] FIG. 8B is a cross-sectional view of the flexible graphite structure 800 when the flexible graphite structure 800 is extended in the stretchable direction.
- [143] Referring to FIG. 8B, when a user manipulates the electronic device such that the display of the electronic device is bent or folded, a force of pulling the flexible graphite structure 800 to either side may be applied to the flexible graphite structure 800.
- [144] When the force of pulling the flexible graphite structure 800 to either side is applied to the flexible graphite structure 800, the stretchable sheet layers 850a and 850b are stretched along the direction of the force, and since the graphite sheet unit 870 is integrally bonded to the stretchable sheet layers 850a and 850b and the graphite sheet layer 810a of the flexible graphite structure 800 includes the overlapping area OL formed by two foldable portions 860, the foldable portions 860 of the graphite sheet layer 810a are unfolded in response to the application of the forces, and the graphite sheet layer 810a can also be extended to either side along the direction of the force. In addition, since the adhesive layers 820a, 820b, 830a, 830b, 840a, and 840b and the graphite sheet layers 810b and 810c are fixedly stacked between the graphite sheet layer 810a and the stretchable sheet layers 850a and 850b, the adhesive layers 820a, 830a, and 840b and the graphite sheet layer 810b move away from the adhesive layers 820b, 830b, and 840a and the graphite sheet layer 810c in response to the extension of

the stretchable sheet layers 850a and 850b and the graphite sheet layer 810a.

[145] When the stretchable sheet layers 850a and 850b are elongated, the stretchable sheet layers 850a and 850b corresponding to the segmented portion between the adhesive layers 830a and 830b and the segmented portion between the adhesive layers 840a and 840b may be elongated from greater than 0 to 50% or less or from greater than 0 to 30% or less.

[146] As the graphite sheet unit 870 is extended to either side, the width of the overlapping area OL gradually decreases, and when the graphite sheet part 870 is maximally extended, the overlapping area OL may disappear.

[147] When the user returns the electronic device to its original state after the operation of bending or folding the display of the electronic device is performed, the force of pulling the flexible graphite structure 800 to either side is released from the flexible graphite structure 800. When the force of pulling the flexible graphite structure 800 to either side is released, the stretchable sheet layers 850a and 850b are contracted back to their original lengths again, and accordingly, the width of the overlapping area OL of the graphite sheet unit 870 increases. As the contraction of the stretchable sheet layers 850a and 850b is terminated, the flexible graphite structure 800 returns to its original shape, that is, to the shape illustrated in FIG. 8A.

[148] FIG. 9A is a cross-sectional view of a flexible graphite structure 900 according to an embodiment of the present disclosure in which an overlapping area is formed as a stretchable area.

[149] Referring to FIG. 9A, the flexible graphite structure 900 includes: a graphite sheet unit 960 including four graphite sheet layers 910a, 910b, 910c, and 910d and adhesive layers 920a, 920b, 930a, 930b, 940a, and 940b formed on the graphite sheet layer 910a, 910b, 910c, and 910d; and stretchable sheet layers 950a and 950b attached to the outermost both sides of the graphite sheet unit 960.

[150] The graphite sheet layers 910a, 910b, 910c, and 910d, the adhesive layers 920a, 920b, 930a, 930b, 940a, and 940b, and the stretchable sheet layers 950a and 950b may be formed of the same materials as the aforementioned graphite sheet layers, adhesive layers, and stretchable sheet layers, respectively, and overlapping descriptions will be omitted.

[151] The graphite sheet unit 960 includes an overlapping area OL formed by overlapping the two graphite sheet layers 910a and 910b. The overlapping area OL refers to an area in which the two graphite sheet layers 910a and 910b overlap each other when viewed in the vertical direction of FIG. 9A, that is, in the depth direction of the flexible graphite structure 900.

[152] The adhesive layers 920a and 920b may be formed on portions where the overlapping area OL is not formed in the graphite sheet layers 910a, 910b, 910c, and

910d, wherein the adhesive layer 920a may be formed between the graphite sheet layer 910b and the graphite sheet layer 910c, and the adhesive layer 920b may be formed between the graphite sheet layer 910a and the graphite sheet layer 910d. The adhesive layers 930a and 930b may be formed between the graphite sheet layers 910a and 910c and the stretchable sheet layer 950a, and the adhesive layers 940a and 940b may be formed between the graphite sheet layers 910b and 910d and the stretchable sheet layer 950b. In addition, the adhesive layers 930a, 930b, 940a, and 940b formed between the graphite sheet layers 910a, 910b, 910c, and 910d and the stretchable sheet layers 950a and 950b may be segmented along the end portions of the graphite sheet layers 910a and 910b in the overlapping area OL. It is possible to make the thickness of the graphite sheet unit 960 substantially uniform by using the adhesive layers 920a, 920b, 930a, 930b, 940a, and 940b and the graphite sheet layers 910c and 910d.

[153] There is no particular limitation on the type or shape of the adhesive layers 920a and 920b formed between the graphite sheet layers 910a, 910b, 910c, and 910d that are spaced apart from each other. However, when the adhesive layers 920a and 920b are, for example, in the form of an adhesive film, the adhesive layers are preferably double-sided adhesive films since adhesion layers are required on the both sides thereof that face the graphite sheet layers 910a, 910b, 910c, and 910d in order to be bonded to the graphite sheet layers 910a, 910b, 910c, and 910d.

[154] When the adhesive layers 930a, 930b, 940a, and 940b formed between the graphite sheet layers 910a, 910b, 910c, and 910d and the stretchable sheet layers 950a and 950b are, for example, in the form of an adhesive film, each of the adhesive layers may be not only a double-sided adhesive film, but also a single-sided adhesive film since it is sufficient if an adhesion layer can be disposed on a surface that faces the graphite sheet layer 910a, 910b, 910c, or 910d.

[155] In the overlapping area OL, the end portions of the two graphite sheet layers 910a and 910b are not bonded to the adhesive layers 920a and 920b and the graphite sheet layers 910c and 910d, and the adhesive layers 930a, 930b, 940a, and 940b are segmented along the end portions of the graphite sheet layers 910a and 910b in the overlapping area OL, so void spaces may be defined therebetween. Accordingly, the overlapping area OL may include void spaces on the opposite sides thereof, and the void spaces may extend in a direction perpendicular to the stretchable direction of the flexible graphite structure 900. Due to the existence of the void spaces, when a force is applied to the flexible graphite structure 900, the flexible graphite structure 900 may be extended along the direction of the force.

[156] FIG. 9B is a cross-sectional view of the flexible graphite structure 900 when the flexible graphite structure 900 is extended in the stretchable direction.

[157] Referring to FIG. 9B, when a user manipulates the electronic device such that the

display of the electronic device is bent or folded, a force of pulling the flexible graphite structure 900 to either side may be applied to the flexible graphite structure 900.

[158] When the force of pulling the flexible graphite structure 900 to either side is applied to the flexible graphite structure 900, the stretchable sheet layers 950a and 950b are extended along the directions of the forces, and since the graphite sheet unit 960 is integrally bonded to the stretchable sheet layers 950a and 950b, the graphite sheet layer 910a of the graphite sheet unit 960 moves in one direction, and the graphite sheet layer 910b moves in the opposite direction to the one direction. In addition, since the adhesive layers 920a, 920b, 930a, 930b, 940a, and 940b and the graphite sheet layers 910c and 910d are fixedly stacked between the graphite sheet layers 910a and 910b and the stretchable sheet layers 950a and 950b, the adhesive layers 920a, 930a, and 940b and the graphite sheet layer 910c move away from the adhesive layers 920b, 930b, and 940a and the graphite sheet layer 910d in response to the extension of the stretchable sheet layers 950a and 950b and the graphite sheet layer 910a and 910b. In particular, since the two graphite sheet layers 910a and 910b are not bonded to each other, but are stacked on each other, the graphite sheet layers can slide and move in the opposite directions by the application of the forces. As the two graphite sheet layers 910a and 910b move in the opposite directions, the graphite sheet unit 960 is also extended to either side.

[159] As the graphite sheet unit 960 is extended to either side, the width of the overlapping area OL gradually decreases, and until the overlapping area OL by the two graphite sheet layers 910a and 910b completely disappears, the flexible graphite structure 900 can be extended.

[160] When the user returns the electronic device to its original state after the operation of bending or folding the display of the electronic device is performed, the force of pulling the flexible graphite structure 900 to either side is released from the flexible graphite structure 900. When the force of pulling the flexible graphite structure 900 to either side is released, the stretchable sheet layers 950a and 950b are contracted back to their original lengths again, and accordingly, the width of the overlapping area OL of the graphite sheet unit 960 increases. As the contraction of the stretchable sheet layers 950a and 950b is terminated, the flexible graphite structure 900 returns to its original shape, that is, to the shape illustrated in FIG. 9A.

[161] FIG. 10A is a plan view of a graphite sheet layer 10 that is applicable to a flexible graphite structure according to an embodiment of the present disclosure in which cutout areas are formed as a stretchable area.

[162] Referring to FIG. 10A, the graphite sheet layer 10 includes two cutout areas 12a and 12b, and the two cutout areas 12a and 12b are provided in a symmetric manner in the graphite sheet layer 10. The graphite sheet layer 10 may be formed of the same

material as the above-described graphite sheet layers, and overlapping descriptions will be omitted.

- [163] The length of the two cutout areas 12a and 12b in a direction perpendicular to the stretchable direction E of the graphite sheet layer 10 may be shorter than the length of the graphite sheet layer 10 in the perpendicular direction, the cutout area 12a cuts one end portion of the graphite sheet layer 10, and the cutout area 12b cuts the other end portion of the graphite sheet layer 10. In addition, the length of the two cutout areas 12a and 12b in the direction perpendicular to the stretchable direction E is 90% or less, or 75% or less of the length of the graphite sheet layer 10 in the perpendicular direction.
- [164] Since the length in the direction perpendicular to the stretchable direction E of the cutout areas 12a and 12b is shorter than the length of the graphite sheet layer 10 in the perpendicular direction, the graphite sheet layer 10 is connected in one sheet in the other areas than the cutout areas 12a and 12b.
- [165] In the graphite sheet layer 10, void spaces are defined by the cutout areas 12a and 12b, and the void spaces extend in a direction perpendicular to the stretchable direction E.
- [166] FIG. 10B is a plan view of the graphite sheet layer 10 when the flexible graphite structure in which stretchable sheet layers (not illustrated) formed on the both sides of the graphite sheet layer 10 are extended in the stretchable direction E.
- [167] Referring to FIG. 10B, a flexible graphite structure including the graphite sheet layer 10 may be used as a heat dissipation sheet in an electronic device equipped with a flexible display which is bendable or a foldable display which folds and unfolds. When a user manipulates the electronic device such that the display of the electronic device is bent or folded, a force of pulling the graphite sheet layer 10 of the flexible graphite structure to either side may be applied to in the graphite sheet layer 10.
- [168] When a pulling force is applied to the graphite sheet layer 10 in the stretchable direction E, the stretchable sheet layers formed on the both sides of the graphite sheet layer 10 are stretched along the direction of the force. Since the graphite sheet layer 10 is integrally bonded to the stretchable sheet layers, the graphite sheet layer 10 is also extended in the stretchable direction E along the direction of the force.
- [169] Since the graphite sheet layer 10 does not have stretchability, if the graphite sheet layer is a flat graphite sheet, it will be torn without being extended even if a force is applied thereto. However, since the graphite sheet layer 10 includes the cutout areas 12a and 12b, the graphite sheet layer 10 can also be extended in the stretchable direction E along the direction of the force in response to the application of the force.
- [170] When the user returns the electronic device to its original state after the operation of bending or folding the display of the electronic device is performed, a pulling force in

the stretchable direction E is released from the graphite sheet layer 10 of the flexible graphite structure. When the force of pulling the graphite sheet layer 10 in the stretchable direction E is released, the stretchable sheet layers are contracted back to the original length thereof, and accordingly the cutout areas 12a and 12b of the graphite sheet layer 10 are also reduced. As the contraction of the stretchable sheet layers is terminated, the graphite sheet layer 10 returns to its original shape, that is, the shape illustrated in FIG. 10A.

- [171] FIG. 11A is a plan view of a graphite sheet layer 20 that is applicable to a flexible graphite structure according to an embodiment of the present disclosure in which cutout areas are formed as a stretchable area. FIG. 11B is a plan view of the graphite sheet layer 20 when the flexible graphite structure in which stretchable sheet layers (not illustrated) formed on the both sides of the graphite sheet layer 20 are extended in the stretchable direction E.
- [172] Referring to FIGS. 11A and 11B, the graphite sheet layer 20 includes two cutout areas 22a and 22b, and the cutout areas 22a and 22b may each have a shape in which one end thereof is bent in the stretchable direction E. Since the features of the graphite sheet layer 20 and the two cutout areas 22a and 22b are the same as those of the above-mentioned graphite sheet layer 10 and two cutout areas 12a and 12b, a description thereof will be omitted.
- [173] FIG. 12A is an actual photograph of a flexible graphite structure according to an embodiment in which an overlapping area is provided as a stretchable area, in the state in which an overlapping area is formed, that is, the state before a force of pulling the flexible graphite structure to either side is applied to the flexible graphite structure.
- [174] FIG. 12B is an actual photograph when the flexible graphite structure of FIG. 12A is extended in the stretchable direction. When a force of pulling the flexible graphite structure of FIG. 12A to either side is applied to the flexible graphite structure, the width of the overlapping area is gradually reduced while the stretchable sheet layers and the graphite sheet layer of the flexible graphite structure are extended to either side along the direction of the force. When the graphite sheet layer is maximally extended, the overlapping area may disappear, and a shape illustrated in FIG. 12B may be exhibited.
- [175] When the force of pulling the flexible graphite structure of FIG. 12B to either side is released, the stretchable sheet layer is contracted back to its original length, and thus the overlapping area is formed again so that the flexible graphite structure may return to the shape of FIG. 12A.
- [176] FIG. 13A is an actual photograph of a flexible graphite structure according to an embodiment in which cutout areas are formed as a stretch area. Two cutout areas are formed in the flexible graphite structure in a direction perpendicular to the stretchable

direction. Since the lengths of the two cutout areas are shorter than the lengths of the graphite sheet layers in a direction parallel thereto, the graphite sheet layers are connected in one sheet other than the two cut areas.

[177] FIG. 13B is an actual photograph when the flexible graphite structure of FIG. 13A is extended in the stretchable direction. When a force of pulling the flexible graphite structure of FIG. 13A to either side is applied, the cutout areas of the graphite sheet layer can be widened and the graphite sheet layer can also be extended along the direction of the force.

[178] When the force of pulling the flexible graphite structure of FIG. 13B to either side is released, the stretchable sheet layer is contracted back to its original length, and accordingly, the cutout areas of the graphite sheet layer are also reduced. As the contraction of the stretchable sheet layer is terminated, the flexible graphite structure may return to its original shape, that is, the shape illustrated in FIG. 13A.

[179] As the force is applied to and released from the graphite sheet layers 10 and 20 of the flexible graphite structure, the above-described operation is repeatedly performed. Through this operation, heat dissipation of the flexible electronic device can be smoothly performed even when a graphite structure with a high thermal conductivity but low flexibility is used as a heat dissipation sheet.

[180] In the above, flexible graphite structures have been described with reference to the embodiments illustrated in the drawings, but these are only exemplary. A person of ordinary skill in the art will understand that various modifications and equivalent other embodiments are possible therefrom. It should be understood that while the embodiments illustrated in the drawings include up to four graphite sheets layers in the graphite structures, the graphite structures of the present disclosure include a single graphite sheet layer or multiple graphite sheet layers, including but not limited to at least two graphite sheet layers, at least three graphite sheet layers, at least four graphite sheet layers, at least five graphite sheet layers, etc. Therefore, the embodiments disclosed herein should be considered from a descriptive viewpoint, rather than from a restrictive viewpoint. The scope of the present disclosure is represented in the following claims rather than in the foregoing description, and all differences within the scope equivalent thereto should be construed as being included in the scope of the present disclosure.

[181] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the disclosures. Indeed, the embodiments described herein may be embodied in a variety of other forms. Furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the disclosures. The accompanying claims and their equivalents are intended to cover

such forms or modifications as would fall within the scope and spirit of the disclosures.

Claims

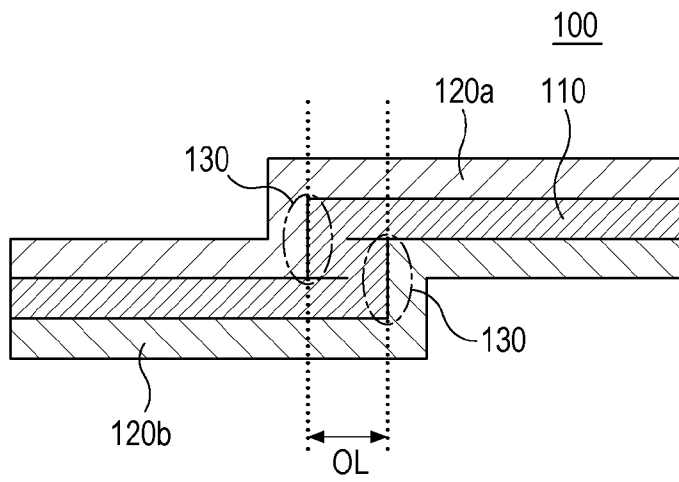
- [Claim 1] A flexible graphite structure comprising:
a graphite sheet unit comprising a single graphite sheet layer or multiple graphite sheet layers having at least one stretchable area; and
a stretchable sheet layer configured to be attached to at least one of both outermost sides of the graphite sheet unit and to cover the at least one stretchable area,
wherein the at least one stretchable area is formed by providing at least one pair of cutout areas in the single graphite sheet layer or by providing an overlapping area where the single graphite sheet layer or the multiple graphite sheet layers overlap.
- [Claim 2] The flexible graphite structure of claim 1, wherein the overlapping area is formed by providing at least two foldable portions in the single graphite sheet layer such that the overlapping area is provided between the foldable portions or is formed by overlapping a portion of the multiple graphite sheet layers.
- [Claim 3] The flexible graphite structure of claim 1, wherein the at least one pair of cutout areas are provided in a point symmetric manner in the single graphite sheet layer, and
the single graphite sheet layer is connected in one sheet in the other areas than the cutout area.
- [Claim 4] The flexible graphite structure of claim 3, wherein the at least one pair of cutout areas have a smaller length than the graphite sheet layer in a direction perpendicular to a stretchable direction of the flexible graphite structure.
- [Claim 5] The flexible graphite structure of claim 4, wherein the length of the at least one pair of cutout areas is 90% or less or 75% or less of the length of the graphite sheet layer in the direction perpendicular to the stretchable direction of the flexible graphite structure.
- [Claim 6] The flexible graphite structure of claim 1, wherein the at least one stretchable area comprises a void space extending in the direction perpendicular to the stretchable direction of the flexible graphite structure.
- [Claim 7] The flexible graphite structure of claim 6, wherein the void space is defined between a graphite sheet layer provided in another area than the overlapping area and a graphite sheet layer provided in the overlapping area, or defined by the at least one pair of cutout areas.
- [Claim 8] The flexible graphite structure of claim 2, wherein if a force is applied

- to the flexible graphite structure, the graphite sheet unit is extended, the stretchable sheet layer is elongated in a direction where the graphite sheet unit is extended, and the width of the overlapping area is reduced.
- [Claim 9] The flexible graphite structure of claim 8, wherein if the force is released, the stretchable sheet layer is contracted and the width of the overlapping area is increased.
- [Claim 10] The flexible graphite structure of claim 3, wherein if a force is applied to the flexible graphite structure, the graphite sheet unit is extended, the stretchable sheet layer is elongated in a direction where the graphite sheet unit is extended, and the size of the void space of the at least one pair of cutout areas is increased.
- [Claim 11] The flexible graphite structure of claim 10, wherein if the force is released, the stretchable sheet layer is contracted and the size of the void space of the at least one pair of cutout areas is reduced.
- [Claim 12] The flexible graphite structure of claim 1, wherein the graphite sheet layer comprises a graphitized polymer or compressed particles of exfoliated graphite, or a combination thereof.
- [Claim 13] The flexible graphite structure of claim 1, wherein the stretchable sheet layer comprises at least one selected among the group consisting of PDMS (polydimethylsiloxane), an epoxy resin, a styrene-based material, an olefin-based material, polyolefin, polyurethane, thermoplastic polyurethane, a thermoplastic elastomer, polyamides, synthetic rubbers, polybutadiene, polyisobutylene, polychloroprene, and silicones.
- [Claim 14] The flexible graphite structure of claim 1, wherein the stretchable sheet layer has an elongation of 175% or greater, or 200% or greater, or 250% or greater.
- [Claim 15] The flexible graphite structure of claim 1, wherein the stretchable sheet layer comprises a thermally conductive material.
- [Claim 16] The flexible graphite structure of claim 1, wherein the graphite sheet layer has a thickness of 15 μm -19 μm , or 16 μm -18 μm .
- [Claim 17] The flexible graphite structure of claim 2, wherein the graphite sheet unit comprises an adhesive layer provided in the graphite sheet layer, the graphite sheet unit having a uniform thickness.
- [Claim 18] The flexible graphite structure of claim 17, wherein the adhesive layer comprises at least one selected among the group consisting of a pressure sensitive adhesive (PSA), a thermosetting adhesive, a photocurable adhesive, an optical clear adhesive (OCA), an optical clear

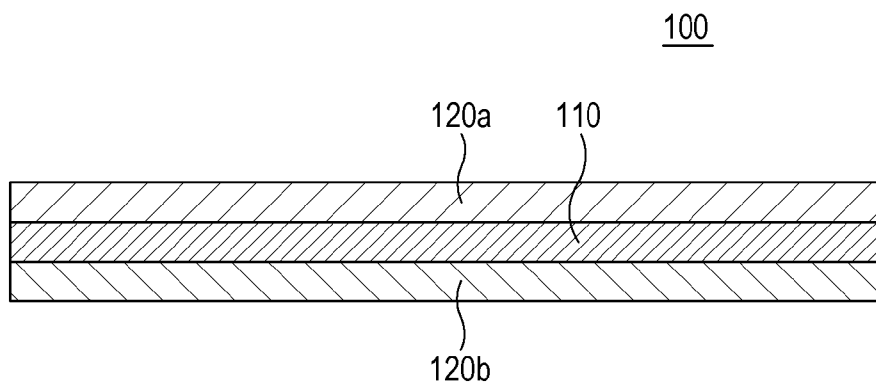
resin (OCR), a double-sided adhesive film, and a single-sided adhesive film.

- [Claim 19] The flexible graphite structure of claim 18, wherein when the adhesive layer is formed between the multiple graphite sheet layers spaced from each other, the adhesive layer is a double-sided adhesive film.
- [Claim 20] The flexible graphite structure of claim 18, wherein when the adhesive layer is formed between the graphite sheet layer and the stretchable sheet layer, the adhesive layer is a single-sided adhesive film.
- [Claim 21] The flexible graphite structure of claim 20, wherein the single-sided adhesive film is bonded to a surface facing the graphite sheet layer.
- [Claim 22] The flexible graphite structure of claim 20, wherein the adhesive layer formed between the graphite sheet layer and the stretchable sheet layer is segmented along the foldable portions of the graphite sheet layer.
- [Claim 23] The flexible graphite structure of claim 12, wherein the graphite sheet layer has an in-plane thermal conductivity of 150W/mK-1700W/mK.
- [Claim 24] The flexible graphite structure of claim 22, wherein when the stretchable sheet layer is stretched, the length of the stretchable sheet layer corresponding to the segmented portion of the adhesive layer is elongated from greater than 0 to 50% or less, or from greater than 0 to 30% or less.

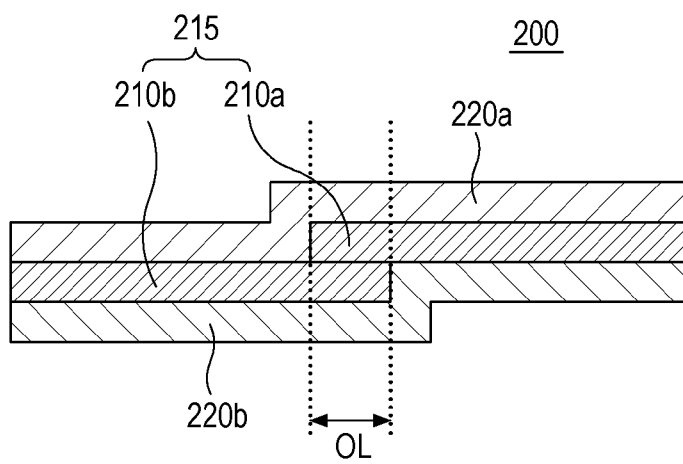
[Fig. 1A]



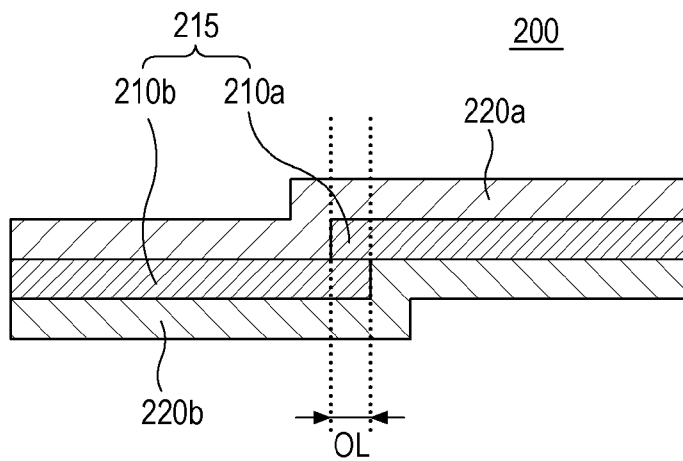
[Fig. 1B]



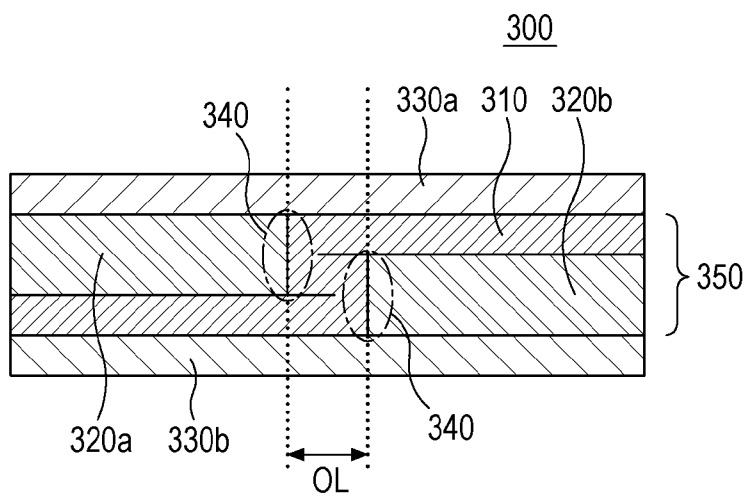
[Fig. 2A]



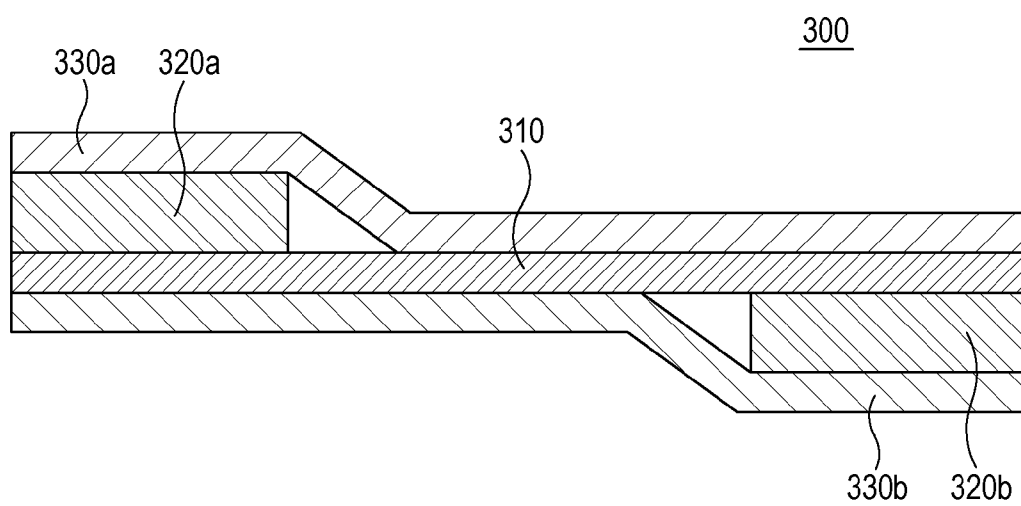
[Fig. 2B]



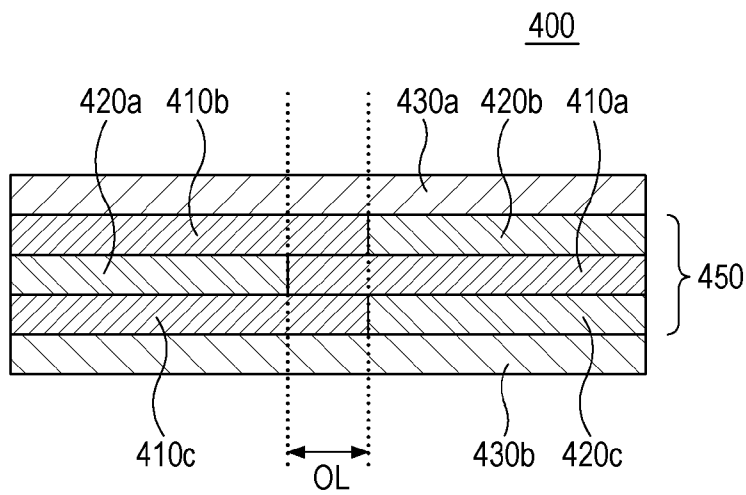
[Fig. 3A]



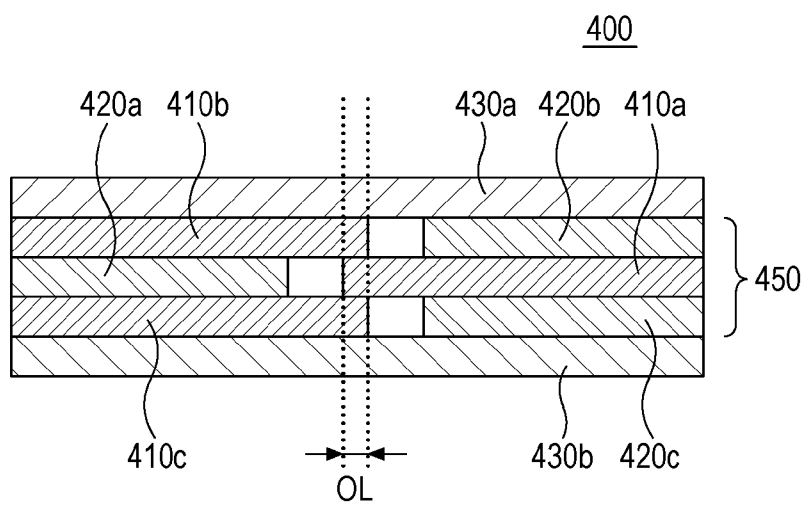
[Fig. 3B]



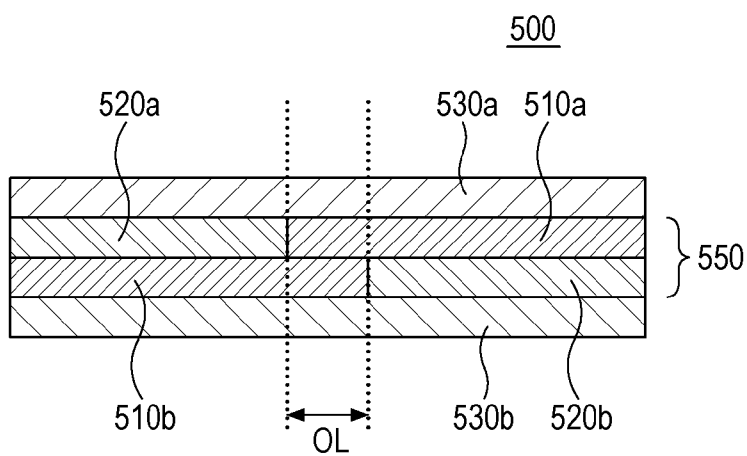
[Fig. 4A]



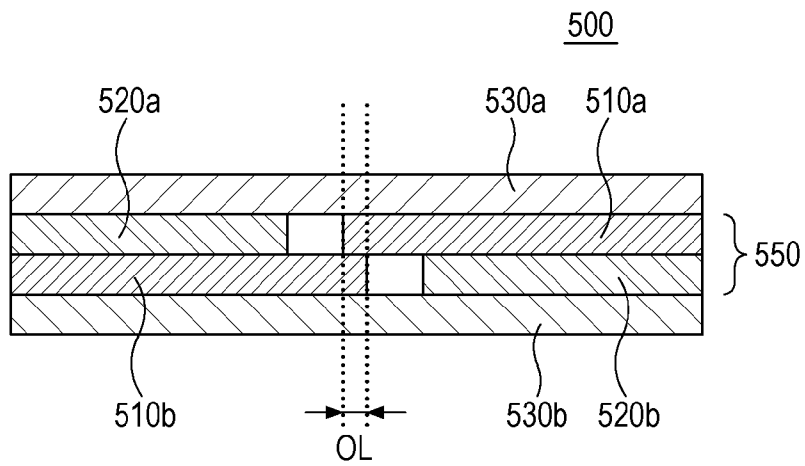
[Fig. 4B]



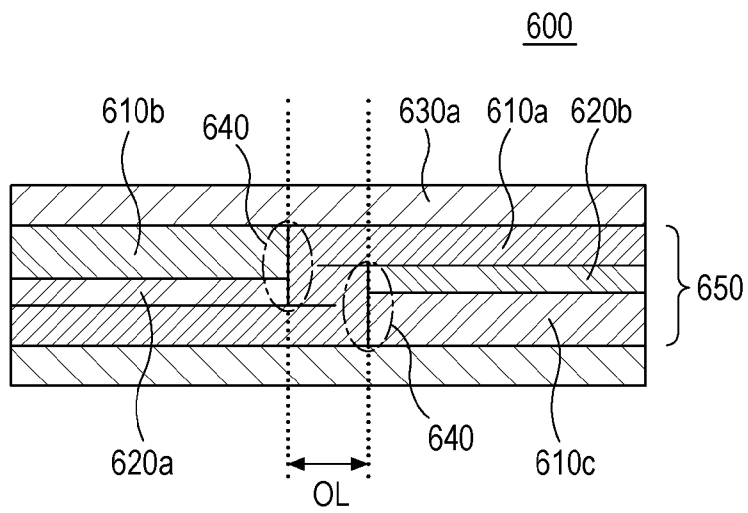
[Fig. 5A]



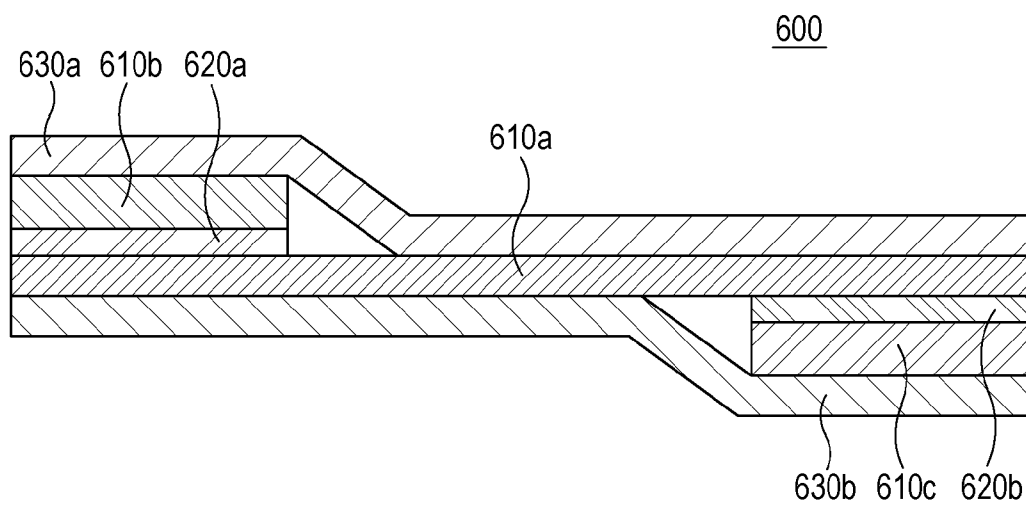
[Fig. 5B]



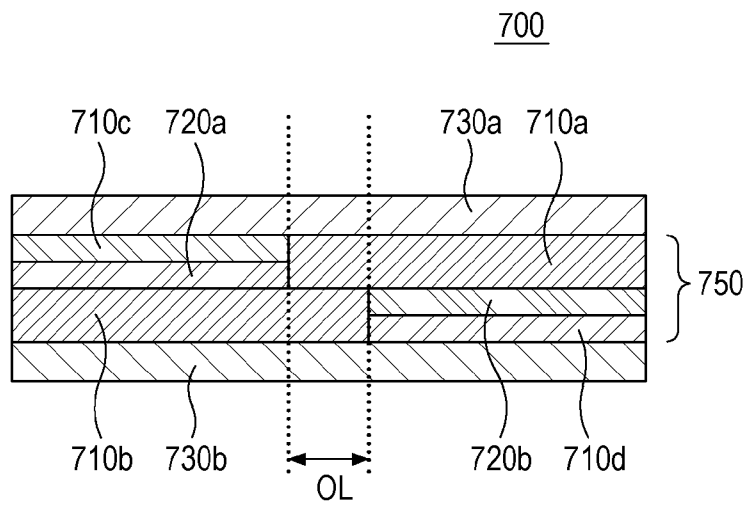
[Fig. 6A]



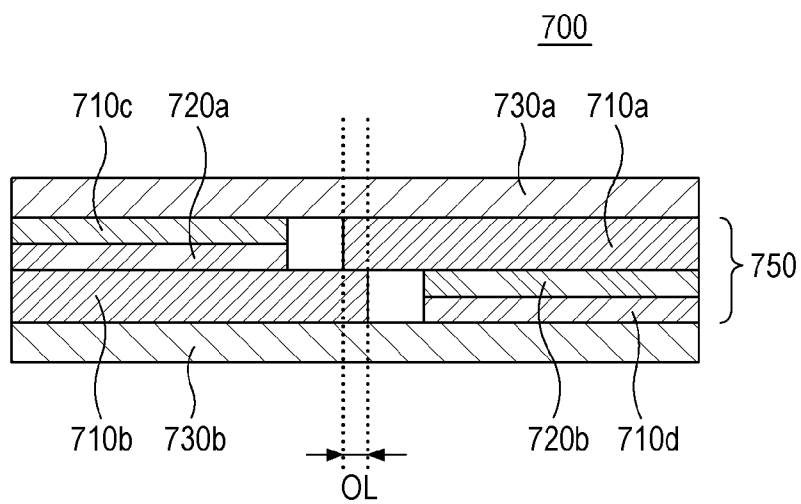
[Fig. 6B]



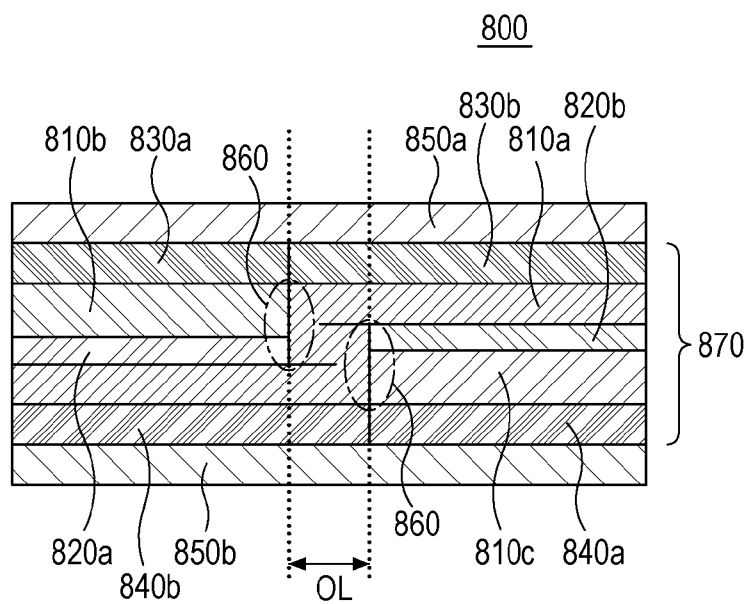
[Fig. 7A]



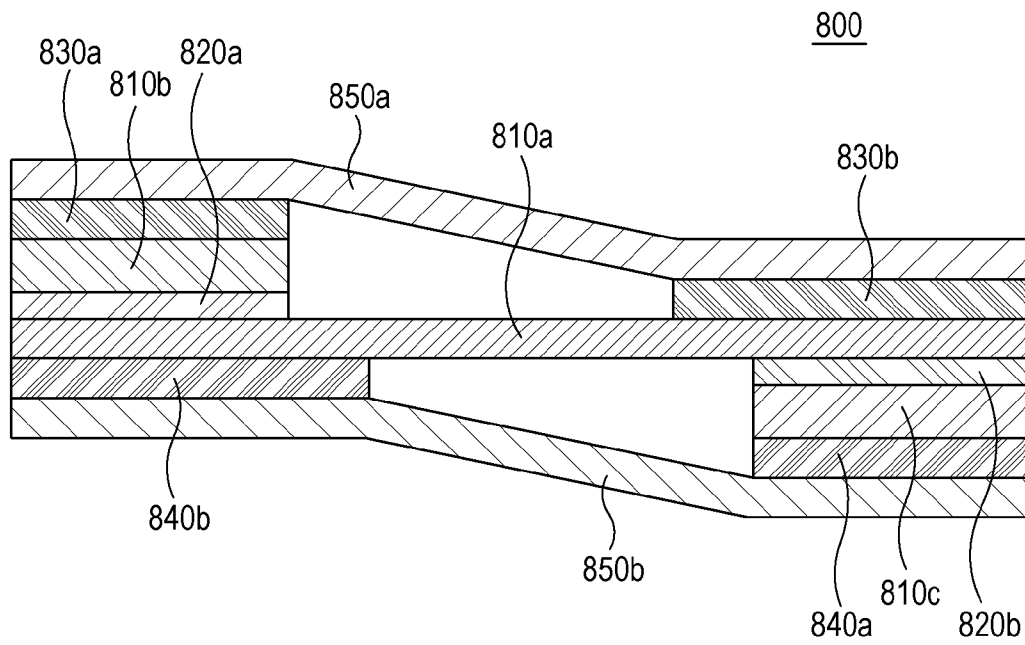
[Fig. 7B]



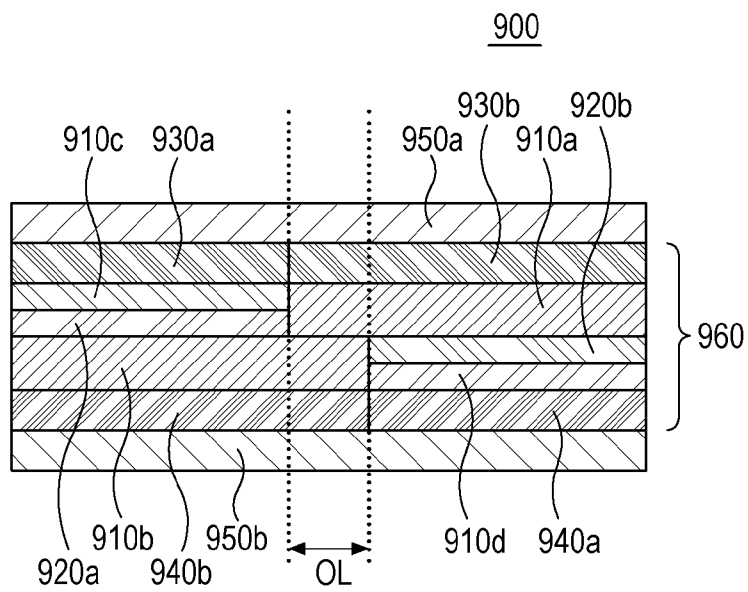
[Fig. 8A]



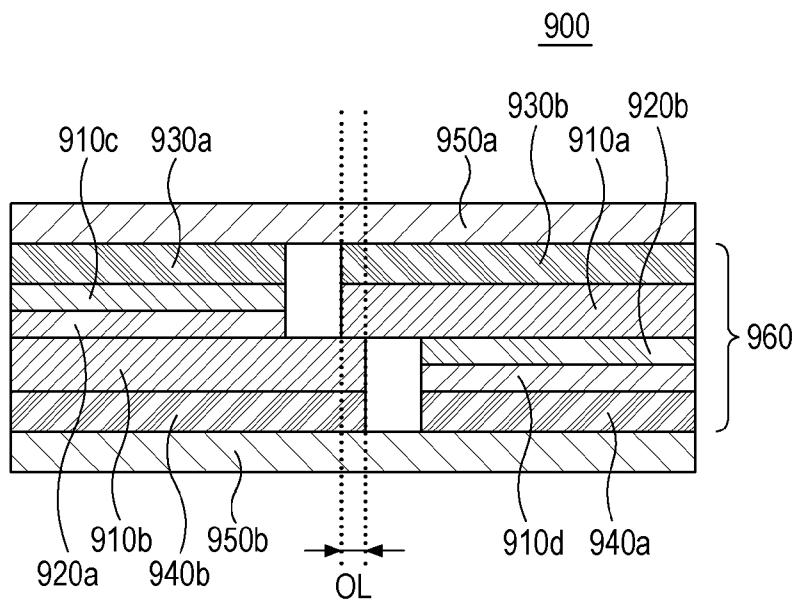
[Fig. 8B]



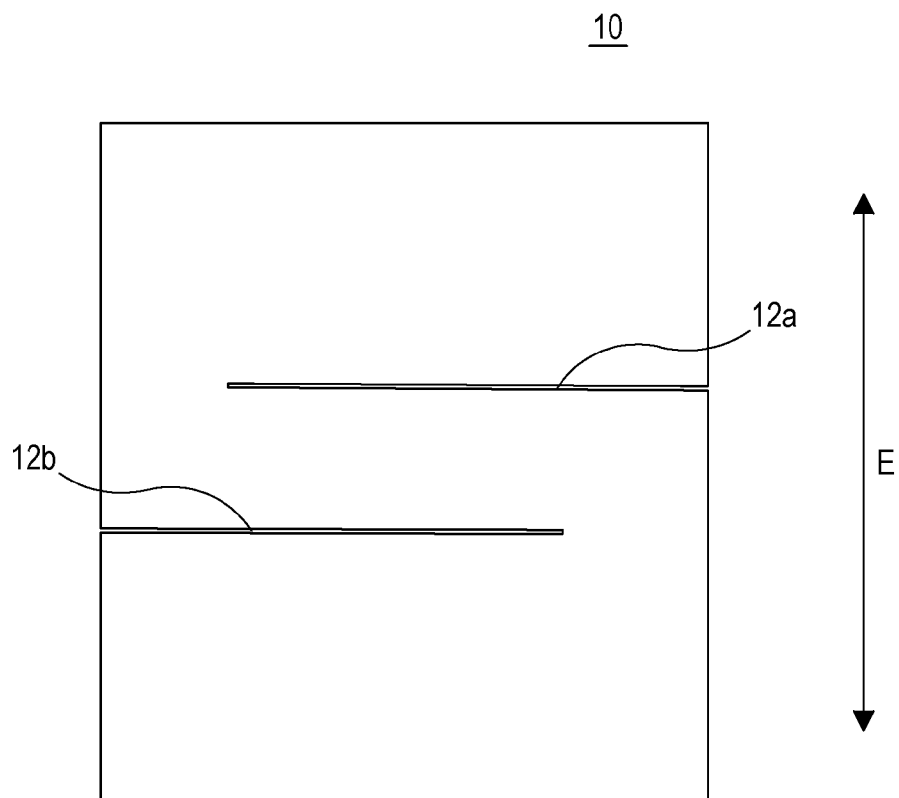
[Fig. 9A]



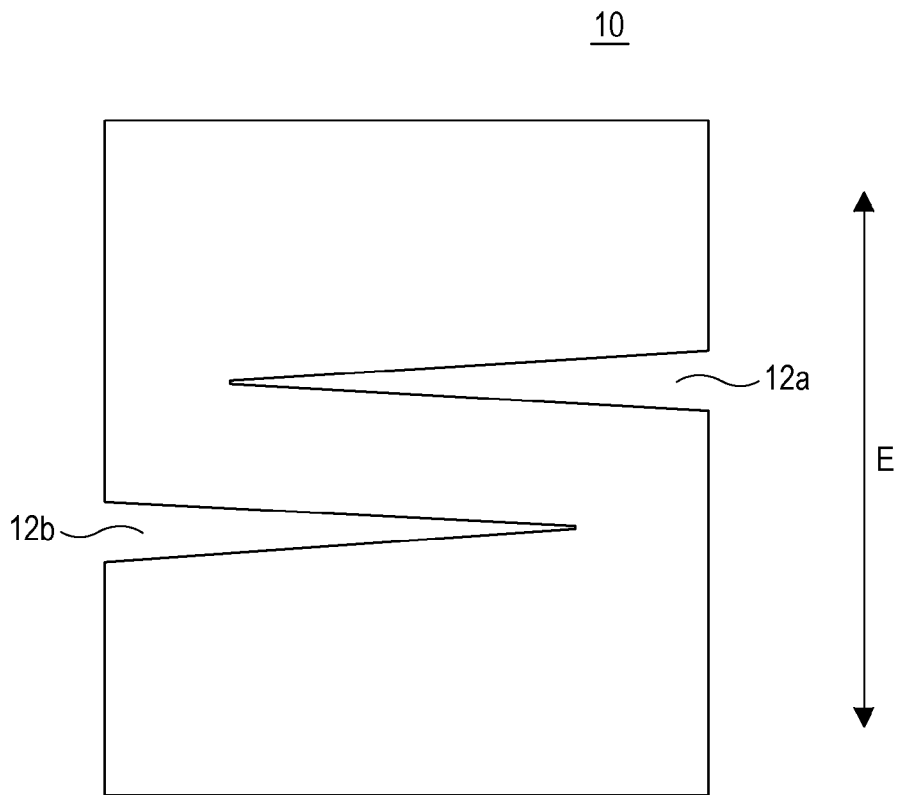
[Fig. 9B]



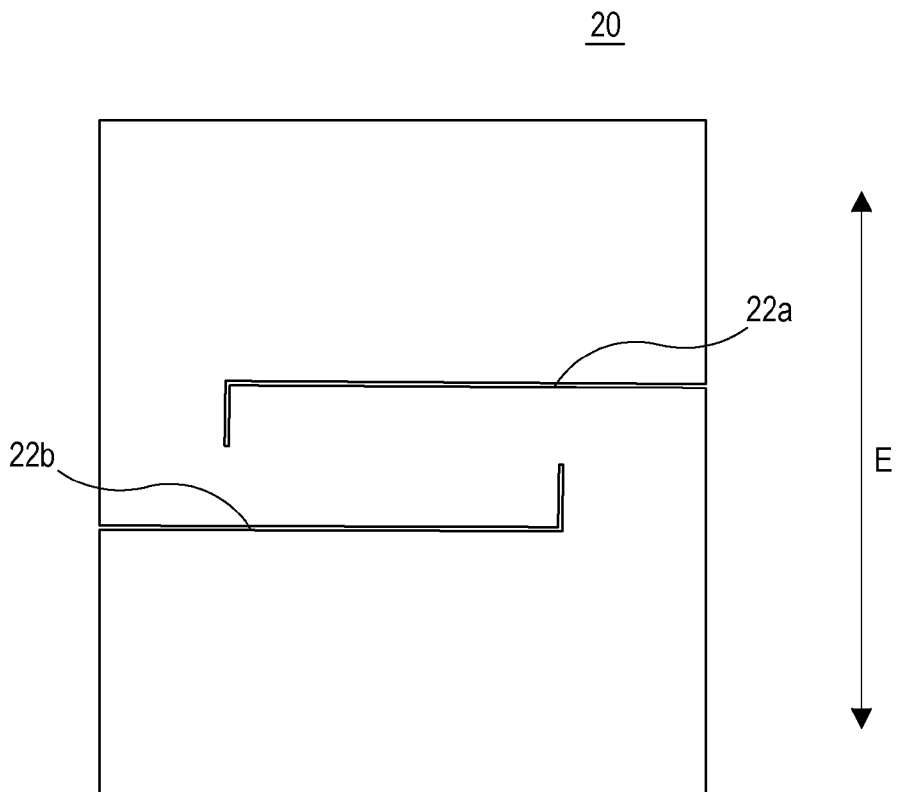
[Fig. 10A]



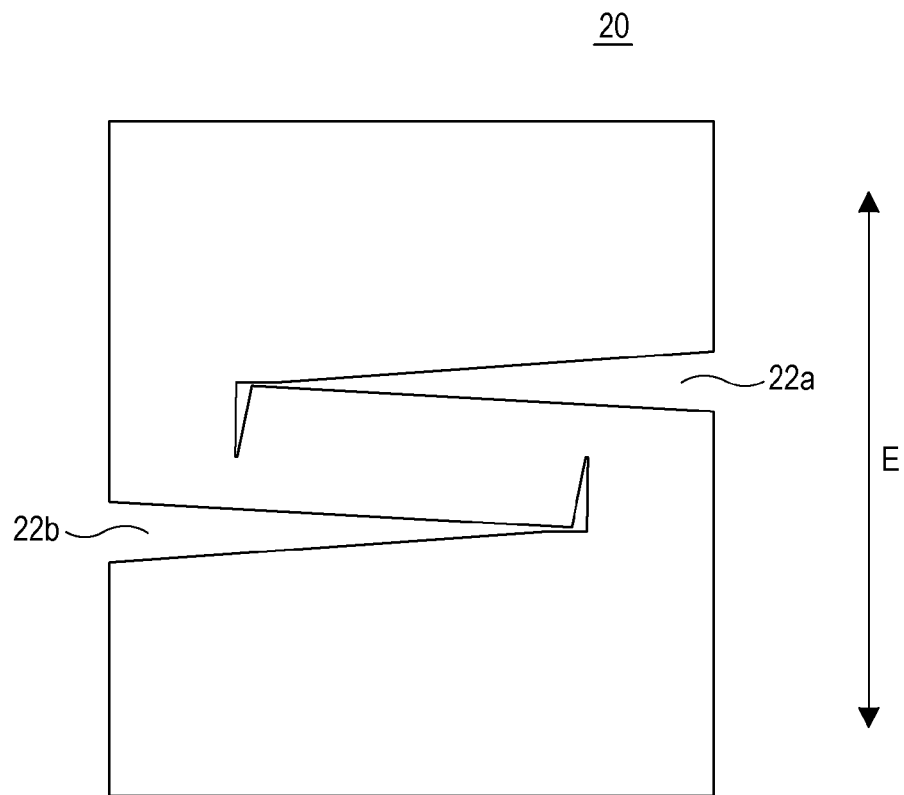
[Fig. 10B]



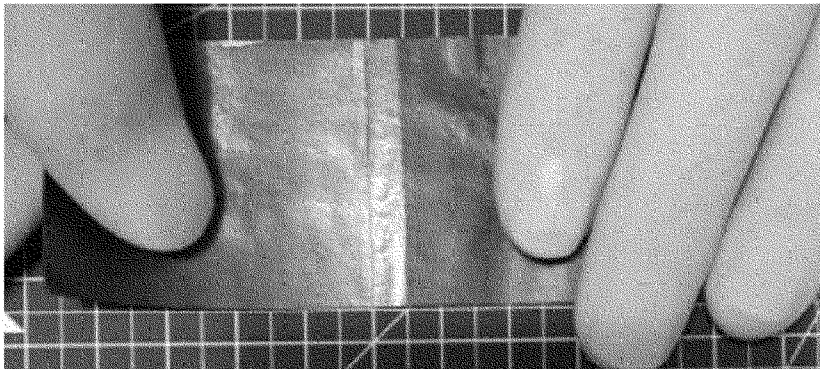
[Fig. 11A]



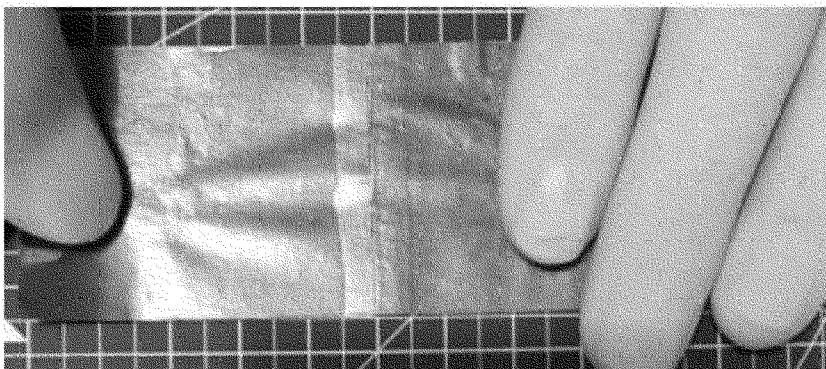
[Fig. 11B]



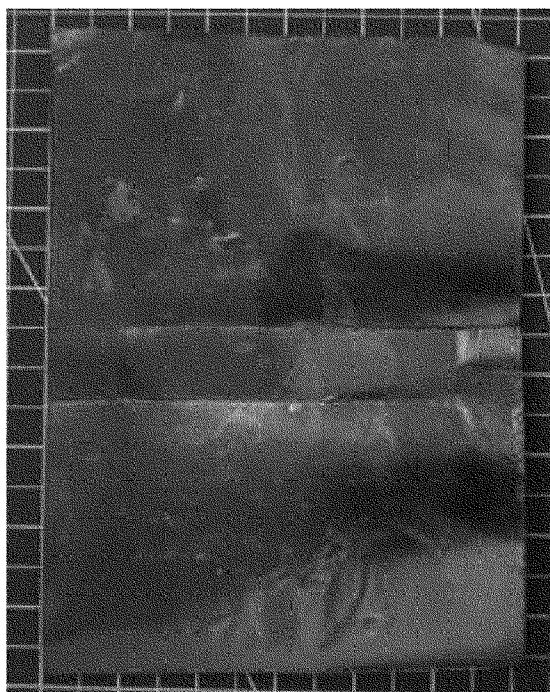
[Fig. 12A]



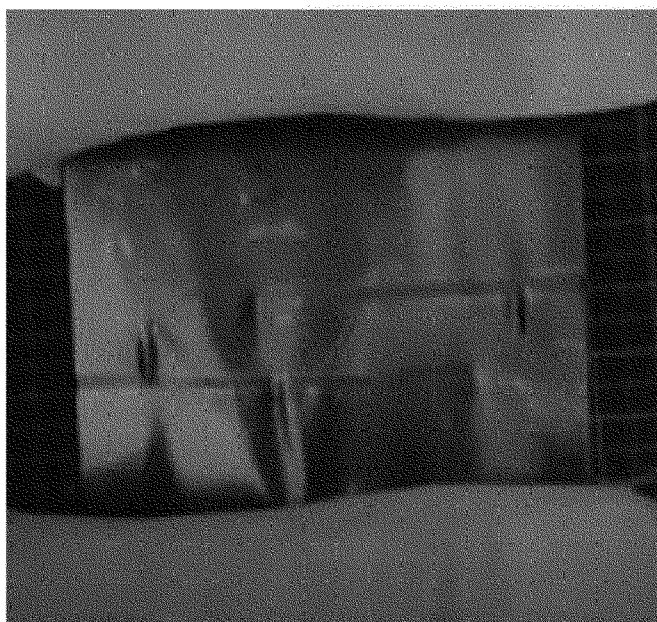
[Fig. 12B]



[Fig. 13A]



[Fig. 13B]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/009844

A. CLASSIFICATION OF SUBJECT MATTER H05K 7/20(2006.01)i; B32B 9/00(2006.01)i; B32B 9/04(2006.01)i; B32B 27/20(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H05K 7/20(2006.01); A41D 13/00(2006.01); C01B 31/02(2006.01); C23C 16/26(2006.01); F28F 3/02(2006.01); H01B 1/22(2006.01); H05K 1/02(2006.01); H05K 1/09(2006.01) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models Japanese utility models and applications for utility models Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS(KIPO internal) & Keywords: flexible graphite sheet, stretchable, cut, overlap, area		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2019-076081 A1 (HUAWEI TECHNOLOGIES CO., LTD.) 25 April 2019 (2019-04-25) Pages 1, 5-7; claim 1; and figures 8, 11.	1,6-7
Y		12-16,23
A		2-5,8-11,17-22,24
Y	US 9807878 B2 (KANEKA CORPORATION) 31 October 2017 (2017-10-31) Column 6, lines 59-65; column 18, lines 52-55.	12,16,23
Y	WO 2018-159374 A1 (TOYOBO CO., LTD.) 07 September 2018 (2018-09-07) Paragraphs 5, 52.	13-15
A	US 6673284 B2 (ROBERT ANGELO MERCURI et al.) 06 January 2004 (2004-01-06) Claims 1-5.	1-24
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "D" document cited by the applicant in the international application "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 14 October 2022		Date of mailing of the international search report 14 October 2022
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon 35208, Republic of Korea Facsimile No. +82-42-481-8578		Authorized officer PARK, Hye Lyun Telephone No. +82-42-481-3463

INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/009844

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

International application No.

PCT/KR2022/009844

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